MAY 1955
No. 206

# ASTM Bulletin

Provisional Program
58TH ANNUAL MEETING
Atlantic City
June 26—July 1

American Society for Testing Materials

# ASTM BULLETIN


## MAY 1955

**Number 206**

**Telephone: Rittenhouse 6-5315** **Cable Address: Testing, Philadelphia**




### IN THE SOCIETY



### GENERAL NEWS NOTES



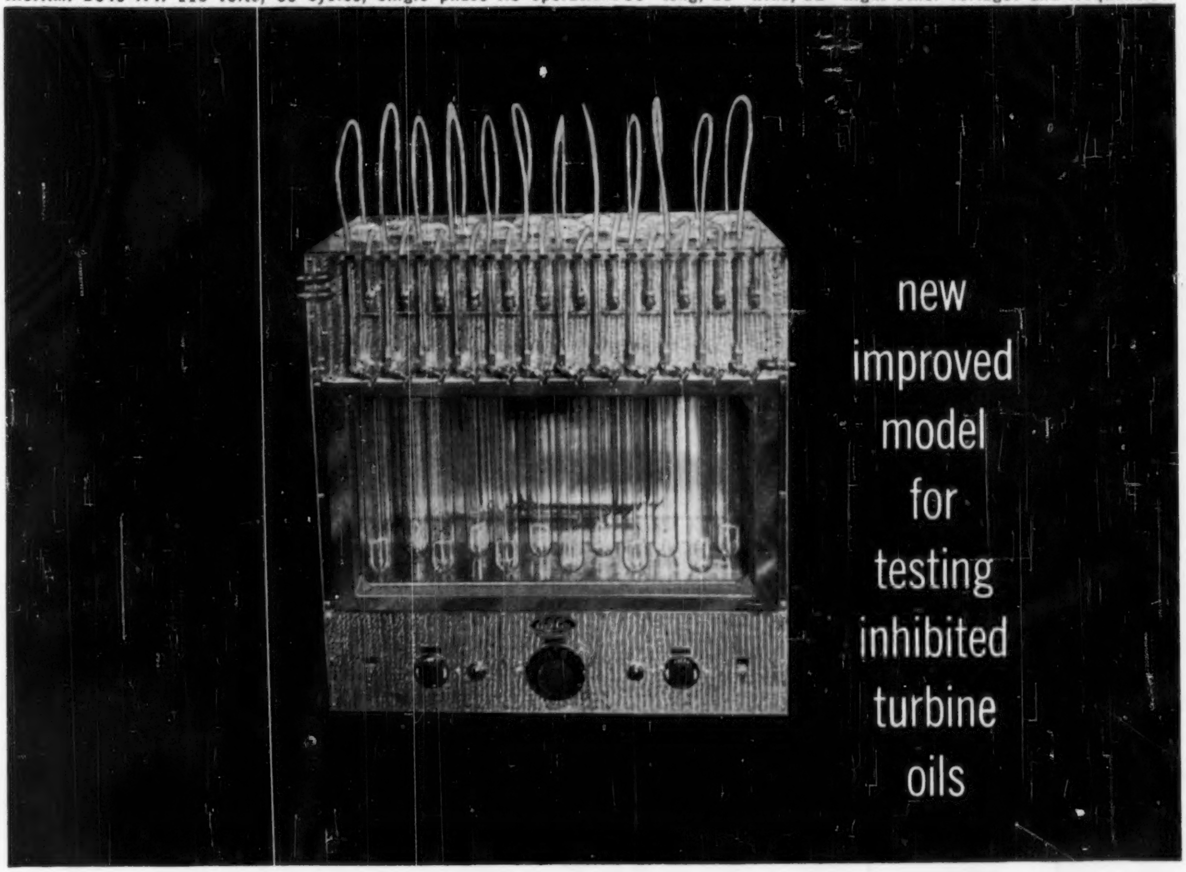

ASTM Bulletin is indexed regularly by Engineering Index, Inc.





ASTM Bulletin, May 1955. Published eight times a year, January, February, April, May, July, September, October, and December, by the American Society for Testing Materials. Publication Office—20th and Northampton Sts., Easton, Pa. Editorial and advertising offices at the headquarters of the Society, 1916 Race St., Philadelphia 3, Pa. Subscriptions, United States and possessions, one year, $2.75, two years, $4.75, three years, $6.50; Canada, one year $3.25, two years $5.75, three years, $8.00. Other countries, one year, $3.75; two years, $6.75; three years, $9.50. Single copies—50 cents. Number 206. Entered as second class matter, April 8, 1940, at the post office at Easton, Pa., under the act of March 3, 1879.

A.S.T.M. D943-47T. 115 volts, 60 cycles, single phase AC operation. 30" long, 18" wide, 32" high. Other voltages and frequencies.




# turbine oil oxidation bath

This bath determines the oxidation inhibitor life of inhibited turbine oils. The oil sample, in the presence of water, oxygen and an iron-copper catalyst, is subjected to a temperature of 95°C ± 0.2°C.

The bath accommodates 12 oxidation test cells. It is made of corrosion resistant stainless steel. It utilizes "flow-rater" type flowmeters, made of pyrex brand glass, with stainless steel floats. Individual needle flow control valves assure a rate of flow of three liters of oxygen per hour to each test cell. The water manifold has valve connections for mushroom type condensers.

The bath's window is made of tempered polished "Tuf-flex" plate glass. Two fluorescent lamps permit the operator to view the rate of oxidation and eliminate the need for removing the cells in determining sample level. A stainless steel centrifugal pump accomplishes uniform stirring without turbulence.

In conjunction with the lo-lag stainless steel heaters, a sensitive mercury-in-glass-type thermoregulator operates a mercury plunger relay on the intermittent heat circuit. Another bank of heaters quickly brings the bath up to operating temperature. An additional heater circuit permits steady continuous heat input. All control knobs are conveniently mounted on the lower front panel for ease of operation.

## PRICE LIST

| | | | |
|---|---|---|---|
| G18765 | Steam Turbine Oil Oxygen Bath, 12 unit improved model, complete as described above but without oil test cells (which consist of test tube, mushroom condenser and oxygen delivery tube). | each | $1,750.00 |
| G18772 | Oil Tube Pyrex brand glass | each | 3.75 |
| G18774 | Mushroom Condenser Pyrex brand glass | each | 7.00 |
| G18776 | Oxygen delivery tube | each | 4.50 |
| G18778 | Copper wire catalyst per 1000 ft. | | 11.50 |
| G18780 | Iron wire catalyst per 1000 ft. | | 6.00 |
| G18782 | Winding fixture for wire catalyst | each | 150.00 |

Send for "Labitems" describing Oxidation Bath and other new petroleum testing instruments

75 years

20-26 N. MOORE STREET DEPT. 229, N. Y. 13, N. Y.

The EMIL GREINER Co.

# ASTM · BULLETIN

*"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"*

Number 206 MAY, 1955


# 58th Annual Meeting

ATLANTIC CITY . JUNE 26–JULY 1

## Big Program Includes Seven Symposiums, Other Technical Sessions, Lectures on Textiles and Metal Powders

SEVEN timely symposiums feature the 32 technical sessions scheduled for the Society's 58th Annual Meeting in Atlantic City, June 26 to July 1. In addition to the sessions, 600 meetings of main technical committees and their subgroups are packed into the full and active week typical of ASTM meetings. The technical program, lectures, special events, and entertainment program are outlined in the following pages.

### Technical Program

All the technical sessions will be held at the headquarters hotel, Chalfonte-Haddon Hall, and unless the necessity of making a last-minute shift arises, all committee meetings will be held at the same hotel. As the Provisional Program indicates, the following symposiums will be held throughout the week:

Impact Testing
Judgment Factors in Soil Testing
Significance of Tests of Concrete
High Purity Water Corrosion
Speed of Testing of Non-Metallic Materials
Atmospheric Corrosion of Non-Ferrous Metals
Metallic Materials for Service at Temperatures above 1600 F

Other sessions will be held on the subjects of Testing, Non-Ferrous Metals, Steel, Concrete, Pyrometry, Fatigue. We shall continue the practice of scheduling the presentation of Committee Reports at 11:30 a.m. and 4:30 p.m. sessions following the main meeting of the committees reporting. The reports to be presented at each session are noted in the Provisional Program.

### Marburg Lecture—Textiles

Walter J. Hamburger, Director, Fabric Research Laboratories, Inc., Boston, Mass. will deliver the 29th Edgar Marburg Lecture on Wednesday afternoon, June 29. Titled "A Technology for the Analysis, Design and Use of Textile Structures as Engineering Materials" the lecture will trace the chronology of textile craftsmanship during the prehistoric era, early civilization, industrial revolution, and especially the development of modern textile science in the brief period encompassing the fourth decade and the early part of the fifth decade of the 20th century. The accomplishments subsequent to H. DeWitt Smith's classic Marburg lecture, "Textile Fibers—An Engineering Approach to Their Properties and Utilization" will be presented with references to specific abstracts from this 1944 lecture. Dr. Hamburger will discuss the newest techniques and equipment employed in the analysis of textiles, mentioning the behavior of textiles in tension, compression, bending, and torsion. He will also take up the effects of structural order upon the physical properties of fibers, the effects of fiber properties upon yarn behavior, the effects of geometry upon fabric behavior, and the importance of these behavior characteristics upon objective and subjective functional performance characteristics of textile structures.

### Provisional Program

**The Provisional Program of the 58th Annual Meeting, outlined on page 8, is designed to give members a comprehensive picture of the sessions, symposiums, and special events of the meeting. Brief abstracts of the papers are provided as well as general statements of the scopes of some of the symposiums.**

**The official Program which members and guests will receive when they register will contain full and final details of the sessions, a complete schedule of committee meetings, and the when and where of the entertainment features of the week.**

### Gillett Lecture—Metal Powders

Fritz V. Lenel, Professor of Metallurgical Engineering, Rensselaer Polytechnic Institute, will present the fourth Gillett Memorial Lecture entitled "Powder Metallurgy—Now (New Techniques, Improved Properties, Wider Use") on Tuesday afternoon, June 28.

This lecture is jointly sponsored by the American Society for Testing Materials and Battelle Memorial Institute and commemorates Horace W. Gillett, the first Director of Battelle, and one of America's leading technologists and metallurgists. Its scope covers subjects pertaining to the development, testing, evaluation, and application of metals.

Dr. Lenel will review growth of powder metallurgy as a method of fabrication for metal products since the war.

Some of these advances have been in the field of "structural parts," components which are molded into a shape exactly or at least nearly the one in which they are to be used in the final assembly. Structural parts from iron powder used to have mechanical properties of the order of a medium grade of gray cast iron. Several methods which are in commercial production have been developed to fabricate parts which are considerably stronger and tougher. In addition to the well-known structural parts from iron, iron-copper, iron-carbon, copper, bronze, brass and nickel silver, parts from various stainless steel compositions and even from titanium are making their appearance.

*THE MARBURG LECTURER . . .*

**Walter J. Hamburger** has spent a quarter of a century in the textile field and is the author of many technical papers on textiles. He was graduated from MIT in 1921 with a degree of Bachelor of Science in Mechanical Engineering and obtained his Master of Science in Textile Technology at MIT in 1941. He received his degree of Doctor of Philosophy in Polymer Mechanics at the Polytechnic Institute of Brooklyn in 1948. Lowell Technological Institute awarded him the honorary degree of Master of Science in 1952. From 1922 to 1925 he was engaged in general engineering and from 1925 to 1930 in industrial engineering in the paper industry. Since 1930 his interests have been in textiles. From 1930 until 1944, he was treasurer and technical director of H. Schindler and Co., Inc., Canton, Mass.; and since 1942 has been Treasurer and Director of the Fabric Research Laboratories, Inc., Boston. In addition to these activities, he has lectured on textile research and technology in the Textile Division of the Graduate School of MIT and at Simmons College, Boston. From 1949 to 1952, he was Adjunct Professor, Polymer Mechanics, at the Polytechnic Institute of Brooklyn. Since 1950 he has been visiting professor at Lowell Technological Institute.

*THE GILLETT LECTURER . . .*

**Fritz V. Lenel** was born in Kiel, Germany, and received his degree of Doctor of Philosophy from the University of Heidelberg. Since coming to this country in 1933 he has engaged in research and development work in the field of powder metallurgy. Since 1947 he has been a member of the teaching staff of Rensselaer Polytechnic Inst. in Troy, N. Y., and now holds the rank of Professor of Metallurgical Engineering. Besides his instructional and consultant duties, Dr. Lenel has devoted considerable time to research and development projects in powder metallurgy sponsored by the Armed Forces and by industry. Dr. Lenel has written numerous papers in his field. As a member of ASTM, he has been active in Committee B-9 on Metal Powders and Metal Powder Products since its organization in 1944, serving as its secretary and chairman. In 1952 he was chairman of the committee which organized the ASTM Symposium on Testing Metal Powders and Metal Powder Products. Dr. Lenel is also a member of Sigma Xi, Phi Lambda Upsilon, the American Society for Metals, the American Institute of Mining and Metallurgical Engineers, the Institute of Metals of Great Britain, and the American Society for Engineering Education.

Perhaps even more important for the future of powder metallurgy are techniques for making semifabricated products, extrusions, forgings, sheet, rod or wire from powder which have properties superior to those made by fusion metallurgy. These techniques have so far been particularly successful in the field of light metals, for example the extrusions of magnesium alloy powders into billets which have exceptional compressive yield strength because of their fine grain size or the extrusion of beryllium powder into billets with superior ductility. One of the most remarkable developments in this field is the so-called SAP process for making aluminum forgings, sheets and extrusions from aluminum flake powder, which have elevated temperature properties much superior to those of any cast or wrought aluminum product. These properties are due to the presence in the structure of SAP of very finely divided particles of a second phase, namely aluminum oxide. Strong efforts are under way to apply the SAP technique to alloys of other base metals. Recent work has shown that it may not be necessary to use a hot working process such as hot pressing or hot extrusion to produce a semifabricated product from metal powders but that it is possible to cold roll metal powders directly into sheet, strip, rod, wire or even tubing, which are then sintered and if necessary reworked and resintered.

Powder metallurgy has also had a significant share in the development of materials which must have high strength when operating at elevated temperatures. This field is at present of highest importance in the design of aircraft propulsion and atomic energy plants. Porous components can be made from metal powders which by means of transpiration cooling can be kept at temperatures well below those of the surrounding gas atmosphere. Materials which are prepared from combinations of metal and ceramic powders, the so-called cermets, appear to have appreciable strength at temperatures above 1600 F where base metal alloys are quite weak. One former important drawback of these materials, their thermal shock sensitivity, seems to have been successfully overcome. The principal research effort in this field is now directed toward increasing their inherently low toughness.

## Committze Meetings

The detailed list of committee meetings to be held throughout the week will be included in the program given out at the Annual Meeting. An advance tentative outline of these committee meetings was included in the April ASTM BULLETIN and more recently in the April 7 letter to members transmitting hotel reservation forms. As has been pointed out in the letter, members should consider the committee meeting schedule as tentative, to be superseded by the call of meetings by committee officers; in other words the official notice for committee meetings and subcommittee meetings will be received directly from the secretary of each committee.

## Preprints of Papers and Reports

Each member should have received by now the preprint request blank mailed to all ASTM members on April 15. The First Installment of preprints should go in the mail about May 20 and

all papers and reports requested in this first installment will be included in this mailing. A second and third installment of preprints will be mailed on June 10 and June 24, respectively. Those registering at the Annual Meeting will have another opportunity to secure preprints of the various reports and papers. It should be borne in mind, however, that all reports and papers may not be available in time to be preprinted.

### Entertainment

Once more the Philadelphia District Council is acting as host for an Atlantic City Annual Meeting. To augment the natural attractions placed at the members' disposal at this very pleasant meeting spot, the local committee plans several entertainment features particularly for the ladies. The main diversions for the men are the President's Luncheon and the Annual Dinner.

#### President's Luncheon

The Society's only function dealing exclusively with ASTM affairs and personalities is the President's Luncheon. Featured are the President's Address by retiring President N. L. Mochel; various awards including honorary memberships to individuals of widely acknowledged eminence in the fields of work covered by the Society, or who have rendered especially meritorious service to the Society; awards to individuals who have rendered distinguished service to the Society along technical lines; and recognition of 50 and 40-year members. There will be no other technical sessions scheduled at this time and all committees have been requested to keep the period from 12 noon to 2:30 p.m. free so that all may attend the Luncheon.

#### ASTM Annual Dinner

The "pause" in the middle of a very busy week will again be the Annual ASTM Dinner. A cocktail party (Dutch treat) will precede the dinner and floor show, featuring nationally known entertainers. This evening, with no speeches or business, will be entirely set aside for relaxation and an opportunity to meet fellow members.

#### Ladies Entertainment

As mentioned above, every effort has been made to provide the ladies with another interesting program. The highlights of the ladies entertainment program will be the Annual ASTM Dinner, President's Luncheon, daily coffee hour, afternoon party at which Mrs. Agnes Smith will discuss floral arrangements and the judging of floral displays, a fashion show with door prize, a sightseeing boat trip, and a smorgasbord luncheon at which Mrs. Rae V. Biester, Superintendent, U. S. Mint, will be guest speaker. An outline of the ladies' program appears in the accompanying box.

### Traveling Print Show

An extra feature of the Annual Meeting, is the Traveling Print Show of the Technical Division of the Photographic Society of America.

The show contains 31 photographs selected from the Tenth Open Exhibit of Technical Photography held in Chicago this year, as part of the PSA 1954 International Exhibition of Photography. This year's show contains entries from a variety of scientific fields—biological and anatomical studies, astronomical and industrial photographs, and a series illustrating the use of schlieren photography.

### Hotel Reservations

Although Chalfonte-Haddon Hall will be the headquarters for the ASTM meeting, sleeping accommodations have been secured from the Colton Manor, Lafayette, Morton, Seaside, and Senator Hotels—all within a very short distance of the headquarters hotel. The Claridge, another boardwalk hotel a few blocks below Chalfonte-Haddon Hall, has also put aside sleeping accommodations for our members. To provide additional "boardwalk hotel" sleeping accommodations, rooms have also been secured from the Dennis and Shelburne Hotels, both adjacent to the Claridge.

Those members who have not as yet returned their hotel reservation form are urged to do so immediately. May 15 is the limiting date the hotels have given for making reservations.

#### Registration Hours

The ASTM Registration Desk, located on the lounge floor of Haddon Hall, will open at 7 p.m., Sunday, June 26. Each day thereafter, it will be open from 8:30 a.m.

### A Plan for Better Presentation of Technical Papers

As announced to the members in the April, 1955, ASTM BULLETIN, p. 15, the Society's Administrative Committee on Papers and Publications will continue the procedure of evaluating presentation of papers, a plan which is intended to obtain livelier, more stimulating sessions by improving the character of presentations of technical papers.

Reporters (not judges) will be chosen by each session chairman and asked to fill out a standard report card for each paper they hear. The check lists include items usually concerned with effective presentation. Copies will be sent, in advance, to each prospective author. During a presentation, the reporter, by check marks and one-word replies will complete a comprehensive, objective statement of what the speaker does and these statements will be evaluated by the Papers Committee. Any author may obtain his check sheet and learn how his presentation was received.

Ideas for refinement and improvement of the system will be welcomed from anyone; these should be sent to the chairman of the Administrative Committee on Papers and Publications at Headquarters. Volunteer comments on particularly well-presented papers would be especially helpful.

### LADIES' ENTERTAINMENT

**MONDAY, JUNE 27**

**9:30 to 10:30 a.m.—Coffee hour**
**3:00 p.m.—Informal get-acquainted party—refreshments. Mrs. Agnes Smith will discuss floral arrangements and points in judging floral displays**

**TUESDAY, JUNE 28**

**9:30 to 10:30 a.m.—Coffee hour**
**12:00 m.—ASTM luncheon with President's Address, awards and introduction of new officers**
**8:00 p.m.—Fashion show—door prizes**

**WEDNESDAY, JUNE 29**

**9:30 to 10:30 a.m.—Coffee hour**
**11:00 a.m.—Sightseeing trip of Atlantic City by boat**
**6:30 p.m.—Cocktails (Dutch) preceding ASTM annual dinner**
**7:30 p.m.—ASTM annual dinner and entertainment**

**THURSDAY, JUNE 30**

**9:30 to 10:30 a.m.—Coffee hour**
**12:00 m.—Smorgasbord luncheon. Mrs. Rae V. Biester, Superintendent, U. S. Mint, will be the guest speaker—"Making Money—A Fascinating Business"**

**FRIDAY, JULY 1**

**9:30 to 10:30 a.m.—Coffee hour**

This Program is Subject to Change

All time indicated is Eastern Daylight Saving Time

# *Provisional Program*

## FIFTY-EIGHTH ANNUAL MEETING

of the

## AMERICAN SOCIETY FOR TESTING MATERIALS

**ATLANTIC CITY, N. J.** **JUNE 26–JULY 1**

**Committee Meetings held throughout the week**

| | MONDAY, June 27 | TUESDAY, June 28 | WEDNESDAY, June 29 | THURSDAY, June 30 | FRIDAY, July 1 |
|---|---|---|---|---|---|
| Morning | —10:00 a.m.—<br>*1st* Opening Session — Symposium on Impact Testing | *5th* Symposium on Judgment Factors in Soil Testing<br>*6th* Session on Non-Ferrous Metals—(B-1, B-5 Reports) | *14th* Symposium on Corrosion—(B-3, Adv. Comm. Corrosion Report)<br>*15th* Session on Concrete—(C-9, C-13 Report)<br>—11:30 a.m.—<br>*16th* Report Session—(Report C-3, C-19, D-5, D-7, D-8, D-9, D-14, D-18) | *22nd* Panel on Pyrometry<br>*23rd* Session on Fatigue | *28th* Session on Fatigue<br>*29th* Session on Effect of Temperature<br>—11:30 a.m.—<br>*30th* Report Session—(Report D-2, D-3, D-6, D-10, D-11, D-15, D-20)<br>*31st* Report Session—(Report A-3, C-7, C-15, D-22) |
| Afternoon | *2nd* Symposium on Impact Testing<br>*3rd* Session on Soils | —12:00 noon—<br>*7th* Luncheon Session—President's Address, Awards<br>*8th* Session on Steel<br>—4:30 p.m.—<br>*9th* Report Session—(Reports A-5, A-6, B-2, B-4, B-8, B-9, E-7)<br>*10th* Report Session—(Reports C-2, C-20, D-16, D-17, E-5)<br>—5:00 p.m.—<br>*11th* Gillett Lecture, Fritz V. Lenel—Powder Metallurgy | *17th* Symposium on Corrosion<br>*18th* Symposium on Speed of Testing—(E-1 Report)<br>—4:00 p.m.—<br>*19th* Report Session—(Report A-1, A-7, A-10, B-6, C-11, E-3, E-4, E-6)<br>*20th* Report Session—(Reports D-1, D-12, D-13, D-21, D-23, E-11, E-12)<br>—4:30 p.m.—<br>*21st* Marburg Lecture, W. J. Hamburger, Textile Fibers | *24th* Symposium on Metallic Materials for Service Above 1600 F<br>—4:30 p.m.—<br>*25th* Report Session—(Report A-2, B-7, E-2, E-13, E-14)<br>*26th* Report Session—(Reports C-1, C-8, C-12, C-14, C-16, C-17, C-21, C-22, D-4) | —1:30 p.m.—<br>*32nd* Session on Fatigue—(E-9 Report) |
| Evening | *4th* Session on Testing | *12th* Session on Significance of Tests of Concrete<br>*13th* Symposium on High Purity Water Corrosion—(D-19, E-10 Reports) | Cocktail Party<br>ASTM DINNER<br>Floor Show | *27th* Symposium on Metallic Materials for Service Above 1600 F (Joint Comm. Ef. Temp. Report) | |

ASTM Registration Desk opens Sunday evening June 26

[NOTE.—It is possible that some of the papers listed in the following provisional program will be presented by title only. Consult the final program for this information.]

## Monday, June 27    10:00 a.m.    First Session

# Opening Session

**Formal Opening of the Fifty-eighth Annual Meeting. President N. L. MOCHEL.**

## Symposium on Impact Testing

The last Impact Symposium was held in 1938. Much technical development since that time has been attributed to information contained in those symposium papers.

Now seventeen years later another Impact Symposium steps into a field that is already brimming with interest and activity. Some phases of this field carry the designation "Environmental Testing."

Along this line, it was suggested some time ago by members of the Impact Committee, of Committee E-1, that papers on shock tests be included in this symposium which would encompass impact in parts, components, and complete structures, and not confine the symposium to notched bar testing. This broadened scope has been undertaken with what appears to be very beneficial enhancement of the practical application of the impact test and of testing at high straining rates.

**Notched-Bar Testing—Theory and Practice.** S. L. Hoyt, Metallurgical Consultant.

**Transition Behavior in V-Notch Charpy Slow Bend and Impact Tests.** Carl E. Hartbower, Watertown Arsenal.

The objective of the investigation was to determine the effects of certain metallurgical variables on the transition behavior in V-notch Charpy specimens tested in slow-bend and impact. The metallurgical variables selected for study were three subcritical heat treatments involving the phenomenon of quench-aging and variations in composition by the addition of varying amounts of carbon and manganese as alloying elements. Particular emphasis was placed on the development of a better understanding of the relationship between (and therefore the meaning of) various performance criteria and their attending definitions of transition temperature.

In slow-bend the criteria under consideration were (1) the temperature resulting in a self-propagating crack at maximum load, (2) the amount of deformation attending the onset of brittle fracture (defined as the highest temperature resulting in a self-propagating crack at maximum load), and (3) the amount of fibrosity attending the onset of brittle fracture.

**Strain Propagation in the Plastic Range.** Derald A. Stuart, Cornell University.

The experimental and theoretical basis of the theories of plastic wave propagation are reviewed with particular emphasis on the investigations of this phenomenon in copper.

In general, the experimental work may be classified into two groups: (1) those experiments in which the propagating strains and some of the stress present are measured during the transient phase of propagation and (2) those experiments in which only the permanent strain remaining after the transient phase is ended is measured and the propagational phenomenon is determined by inference. The reasons for some conflicting interpretations of the data are speculated upon and further experimental work proposed to determine the validity of such speculations.

**Reproducibility of Charpy Impact Testing** David E. Driscoll, Watertown Arsenal.

A 15-min sound film showing methods of machining, grinding, notching, and inspecting V-notch Charpy impact test specimens; the method of checking the squareness of the specimen, and the techniques of cooling and testing. High-speed shots (3000 frames per sec) on a specimen that is square and another that is 0.002 in. out of square shows that the out of square has "spins" after breaking. This is not encountered with a square bar. These high-speed shots also show that when the side supports are too close to the ends of the specimen (¼ in.), the broken halves hit the side supports, bounce back, and hit the pendulum. Additional shots show that where the supports are widened, the specimen halves will fly out without coming in contact with the pendulum.

The slides will show the variations encountered in Charpy machines used in private industry, and how this variation has been successfully reduced when the machine has been overhauled and proper testing techniques have been shown to the operating personnel.

**Automatic Impact Testing to −236 C.** Thomas S. DeSisto, Watertown Arsenal.

This paper describes an automatic device which houses, within a vacuum, a complete Charpy impact testing machine and storage space for 105 Charpy V-notch specimens.

Using liquid nitrogen and liquid helium as coolants, impact tests have been conducted from room temperature to −236 C on AISI 4340 steel and a 6 Al, 4V titanium alloy. Comparison impact tests of AISI 4340 conducted on both a standard and the low-temperature impact machine to −196 C show that the device is a useful and accurate impact tool.

*(Continued in Second Session)*

## Monday, June 27    2:00 p.m.    Second Session

Held simultaneously with the Third Session

## Symposium on Impact Testing *(Continued)*

**The Influence of Pendulum Flexibilities on Impact Energy Measurements.** J. I. Bluhm, Watertown Arsenal.

It has been observed that identical specimens tested in various pendulum-type impact machines give rise to different energy levels. This discrepancy is not attributable to differences in impact velocity and its related strain rate effects on the material. It is, instead, hypothesized that the flexibilities of impact machines give rise to a potentially significant error in the usual impact test. An overly simplified and idealized model of an impact machine is analyzed in some detail. In particular, the relation between the stiffness of the machine, the effective stiffness of the specimen, and the maximum load developed is explored.

**The Impact Tube: A New Experimental Technique for Applying Impulse Loads.** George Gerard, New York University.

This report is concerned with the development of a new experimental technique for applying loads of an impulsive nature to diaphragms or plates of various shapes. Briefly, this technique utilizes an adaptation of the shock tube principle, which has been used successfully in the investigation of various supersonic aerodynamic problems. By rupturing a diaphragm, which separates a high and a low-pressure chamber, an expansion wave is created which travels toward the opposite wall of the high-pressure chamber which contains the specimen under investigation. Behind the specimen is another high-pressure chamber. As the wave impinges on the specimen, a pressure differential between the second chamber and the pressure wave is applied to the specimen in an impulsive manner.

For example, this technique can be used to study the dynamic response of plates or the strength characteristics of membranes. The various advantages of this new technique over the methods in current use are discussed. Considerations involved in the design of the various components of the impact tube are discussed in detail. The results of an exploratory program on the dynamic pressure-strain relations in the yield region are presented for aluminum alloy 2S-0, annealed type 302 stainless steel, and annealed low carbon steel.

**Longitudinal Impact Tests of Long Bars with a Slingshot Machine.** W. Ramberg and L. K. Irwin, National Bureau of Standards.

The history of the longitudinal impact test is reviewed briefly to show the need for further tests under controlled conditions. A slingshot machine for making such tests at the National Bureau of Standards is described and results are given for impact tests on bars of steel and of copper. These show that the strain pulses were attenuated in the steel with much less change in shape than that corresponding to the simple Karman theory of plastic strain waves. High-strength steel exhibited a "time delay" between the sudden application of a high stress and the initiation of yielding which decreased with increasing stress in accord with the dislocation locking theory of Cottrell as developed by Yokobori.

**Shock Tester for Shipping Containers.** W. H. Cross and Max McWhirter, Sandia Corp.

The object of this investigation was to develop a method of testing shipping containers for the longitudinal shocks encountered during railroad switching operations. Field data were gathered by measurement of accelerations encountered on a railroad car during various controlled switching conditions at speeds up to 10 mph.

The test method employs shock spectra analysis as a means of comparison of field and test data. The fixture for testing shipping containers that has been developed will simulate the longitudinal shocks encountered during railroad switching impact velocities of 8 mph for shock mitigating systems with resonant frequencies below 20 cps.

**Properties of Concrete at High Rates of Loading.** D. Watstein, National Bureau of Standards.

The effect of the rate of application of load was investigated in compressive tests of a concrete having a nominal static strength of 2500 psi. The test specimens were 3 by 6-in. cylinders and the loads were applied at stress rates ranging from about 10 to $2 \times 10^7$ psi per sec. The compressive strength of the concrete increased with the rate of loading. The maximum ratio of dynamic to static compressive strength was about 1.8 for the maximum rate of loading of $2 \times 10^7$ psi per sec. There was a significant increase in the secant modulus of elasticity as the rate of loading increased. The resistance of concrete to impact as measured by its ability to absorb strain energy also increased with the rate of application of load.

## Monday, June 27 2:00 p.m. Third Session

Held simultaneously with the Second Session

## Session on Soils

**Soil Density Determination by Direct Transmission of Gamma Rays.** R. K. Bernhard and M. Chasek, Rutgers University.

The significant question raised in this study is whether the standard, rather destructive procedures for determining soil densities can be supplemented or replaced by less destructive or non-destructive methods. An investigation on soil density determination by means of gamma-ray transmission was undertaken and experiments in the laboratory and in the field are described.

A radiation source of 60 millicurie (irradiated cobalt 60) and a radiation detector, consisting of a scintillation head in combination with a binary counter, were available. Fourteen different soils, characteristic of the State of New Jersey, have been investigated under various compaction and moisture conditions.

Equations were derived between soil density, as the unknown variable, transmitted radiation energy through the soil, as a measurable variate, and distance between radiation source and detector as an arbitrarily selected variable.

Further investigations are suggested to study the relationship between absorption coefficients, primary rays, and scattering effects as well as the development of smaller and more rugged equipment for field use.

**Pressure Distribution Along Friction Piles.** L. C. Reese, Mississippi State College and H. B. Seed, University of California.

A knowledge of the pressure developed between a pile and the surrounding soil, and the pore water pressures developed in a saturated clay soil as a result of pile driving is required to determine the load-carrying ability of the pile from soil tests. This paper describes an investigation made to determine the distribution of pressure along a friction pile driven into clay and the variation of pressure with time.

SR-4 electric strain gages were installed on one pile to measure load and pressure distribution; this pile was test loaded soon after driving and a number of times thereafter. The total pressures and pore water pressures caused by action of soil against the pile wall were measured at several points along the pile length during pile driving and during the load-test period. The relationship between excess hydrostatic pressure in the clay and the supporting capacity of the pile is demonstrated.

Analyses are proposed for determining the magnitudes of the total, effective, and pore water pressures on the pile during pile driving and the rate of decay of excess hydrostatic pressure around the pile. The theoretical values are compared with the test data. Pressures on the pile at the end of the test period and pressure effects on the instrumented pile due to driving adjacent piles are analyzed.

**Some Laboratory Tests for the Evaluation of Stabilized Soils.** T. Y. Chu and D. T. Davidson, Iowa State College.

In recent years, various methods of soil stabilization have been developed for use in the construction of highways and airfields. Since the properties and environmental conditions of soils vary so greatly from place to place, it is usually advisable to evaluate several of the methods before deciding on the method to be used for a given job. A complete evaluation for this purpose may require extensive laboratory testing as well as field experiments. This paper presents some test methods which can be used for the laboratory evaluation of stabilized soils.

The test methods presented include (1) a flexural strength test, (2) an unconfined compression test, and (3) a miniature bearing test. Comparatively small specimens are used to save time and material in making evaluation tests. Soils containing sand-size or finer particles can be tested satisfactorily by using specimens of these sizes.

The apparatus, procedures, and typical test data obtained with various kinds of stabilized soils are included and, in addition, procedures are given for determining moisture-density relationships for natural or stabilized soils by using the molding apparatus designed for these tests.

**Relationship Between Moisture Tension Values and the Consistency Limits of Soils.** Ralph L. Rollins and D. T. Davidson, Iowa State College.

For a number of years, soil physicists have used the capillary potential as a means of expressing the energy of attraction of soil for water. The so-called tension-moisture curves have been used to characterize soils and to display soil moisture relationships. Equipment is now commercially available by which tension values and moisture content data can be determined for a large number of samples at one time. This paper presents the relationship between tension values and the consistency limits for a large number of soils covering a broad range in textural classification.

Procedures are outlined for the determination of the capillary potential-moisture content curves and data are presented showing the relationship between tension values and the liquid and plastic limits. Tension values for at least 31 duplicate samples can be obtained in a 24-hr period with the apparatus used. By making use of the correlation data presented, considerable time can be saved in estimating the consistency limits. After estimation of these limits, there are, in addition, sufficient data to plot tension-moisture curves to further aid in characterizing the soil.

**The Use of Laboratory Tests to Develop Design Criteria for Protective Filters.** K. P. Karpoff, Bureau of Reclamation.

Protective filters are often used with foundation soils of engineering structures to prevent erosion or uplift pressure from seepage water. It is important that the gradation of the filter materials be carefully selected with respect to the gradation of the base material. The laboratory tests for the development of filter selection criteria are reviewed. The test results led to the recommendation of simple numerical relationships between base and filter materials for designing of protective filters. Examples of testing equipment and filter construction recommendations are given.

## Monday, June 27 8:00 p.m. Fourth Session

## Session on Testing

**A Remotely Operated Extensometer.** R. G. Berggren and J. C. Wilson, Oak Ridge National Laboratory.

A sensitive extensometer for use in remotely controlled tension testing of radioactive specimens is applied to or removed from the specimen by remote control, may be left on until fracture, and has been used on a wide variety of flat and round specimens without adjustment. A linear differential transformer is used as a transducer element with magnification obtained electronically.

Certain other features, such as: magnifications as great as 6000 with a range of 0.12 in., electronically variable magnification and scale zero suppression, and permanent mounting on tension testing machine or specimen grip, are shown to offer numerous advantages for routine tension testing or research.

**Certain Departures from Plastic Ideality at Large Strains.** H. A. Lequear and J. D. Lubahn, General Electric Co.

The conclusions from an earlier paper, which were restricted to plastic strains less than 1 per cent, have been extended by additional experiments to cover strains up to necking (30 per cent). The experiments consist of room-temperature tests on OFHC copper, and show that the results of creep tests and tension tests can be related, within certain limitations, in terms of the rate sensitivity. Rate sensitivity is the increase in stress required to cause a certain increase in strain rate at a given strain. The above relation between creep and tensile behaviors is a consequence of the concept that plastic deformation behavior depends essentially on current conditions, and not on the prior history. This relation is restricted to isothermal conditions and monotonic loading (increasing or constant, but not decreasing, load).

**A Diameter Gage and Dynamometer for True Stress-Strain Tension Tests at Constant True Strain Rate.** G. W. Powell, E. R. Marshall, and W. A. Backofen, Massachusetts Institute of Technology.

A detailed design is presented for a diameter gage and dynamometer with which it is possible to establish true stress-strain tension curves at constant true strain rates. Resistance strain gages are employed as basic components of both the diameter gage and dynamometer. This apparatus functions in the temperature range of 20 to −196 C and has the advantage that the room temperature diameter calibration suffices for all testing temperatures. To illustrate the use of the apparatus and the information that it can provide, typical data are included from tests on type 301 austenitic stainless steel at several strain rates at temperatures of 20 and −196° C.

**High Speed Tension Testing Machine for Plastics.** James Dorsey, Frederick J. McGarry, and Albert G. H. Dietz, Massachusetts Institute of Technology.

The design, development, and operation of a high speed tension testing device is presented and discussed. The apparatus is capable of presenting and recording stress-strain information during a tension test with a plastics specimen consuming a time interval of 5–15 milliseconds from the start of loading to fracture. Oscilloscope cameras provide permanent records of strain information. Some data on several representative plastics taken under the previously described conditions are presented.

## Tuesday, June 28 9:30 a.m. Fifth Session

Held simultaneously with the Sixth Session

## Symposium on Judgment Factors in Soil Testing

Discussions at recent meetings of ASTM Committee D-18 on Soils for Engineering Purposes have demonstrated the concern with which many practicing engineers view the indiscriminate use of the results of standard soil tests, made possible by the publication of ASTM standards in this field. This symposium therefore takes the form of a critical review of the history of Committee D-18, the work it has done, and the course it should chart for its future program. Although this is a useful occasional procedure for any active specifications committee, it is considered to be essential for D-18 in view of the unique character of soil, when considered as an engineering material.

**The History and Development of Committee D-18.** E. J. Kilcawley, Rensselaer Polytechnic Institute.

Committee D-18 was organized in 1936 and in 1944 was reorganized in its present form. Since then the committee has prepared twenty-two procedures for soil testing and held thirteen symposiums on various aspects of soil testing. These include exchange phenomenon, the use of radioisotopes, and dynamic testing and are published as Special Technical Publications of the Society.

The 1944 edition of Procedures for Testing Soils was rewritten and enlarged in 1950 and a new edition is now under consideration.

The purpose of this symposium is to review critically the work of the committee and the specifications it has developed. It is, therefore, the hope of the committee that frank and full criticisms be presented in both the papers and the discussions. These will serve as an invaluable guide in an attempt to plan an effective program for the future work of the committee.

**Judgment Factors and the Environment in Soil Testing.** D. M. Burmister, Columbia University.

In fifteen years of activity Committee D-18 has achieved notable progress and wide recognition. Each new decade, however, should have its own objectives and sense of pioneering, and should revise upward its concepts of *adequacy* in the light of increased knowledge. The first fundamental concept now to be emphasized concerns the dominating influences of the environmental and imposed conditions upon the responses and performances of soils in actual practice. Unfortunately the results of soil tests made under a single set of relatively arbitrary average test conditions can not usually be translated into reliable predictions of performances of soils under quite a different set of real conditions in the natural environment. It therefore becomes essential, as a second fundamental concept, to work out a definite place in soil-testing methods, and to formulate working principles of soil testing, so that the results of soil tests may properly reflect these dominating environmental influences. Working principles of soil testing are suggested with their implications. Judgment factors now enter soil testing specifically and importantly in selecting and applying appropriate *test conditions* to reproduce as faithfully as possible the actual field conditions in a particular situation. Thus the measured responses of the soils obtained may be made to have direct, reliable, and valid applications in predicting the field performances of soils, as an adequate basis for design and construction of foundations of structures and of earthworks.

NOTE—It is suggested that the committee members read "The Philosophy of Simulated Service Testing," by S. A. Gordon, ASTM BULLETIN, October 1953, p. 27.

**Future Possibilities and Activities of Committee D-18.** K. B. Woods, Purdue University.

The work of Committee D-18 on Soils for Engineering purposes should continue in the general direction of developing methods of tests plus some work in the specification field. Construction practice in the field of soil mechanics should continue to be within the scope of the American Society of Civil Engineers and the excellent work of the Highway Research Board in the general field of research is properly covered by that group. Because of the complex character of soils, it is not likely that any great amount of standardization can be effected in the foreseeable future. Nevertheless, it is important to have an organization such as the American Society for Testing Materials serve in the coordinating capacity to bring together the material in this vast field of soil testing.

## Tuesday, June 28 9:30 a.m. Sixth Session

Held simultaneously with the Fifth Session

## Session on Non-Ferrous Metals

**Mechanical Properties of a Magnesium Alloy Under Biaxial Tension at Low Temperatures.** Edward Paxson, Edison Laboratory, Joseph Marin and L. W. Hu, The Pennsylvania State University.

This paper describes an experimental investigation on the mechanical properties of a magnesium alloy FS-1-H24. The properties in both simple tension and biaxial tension were obtained at various low temperatures. Biaxial tension properties were determined by the bulge type test, using a thin circular plate clamped at the edges and subjected to lateral hydrostatic pressures. The test results showed that the experimental plastic stress-strain relations can be expressed by the simple flow theory. The ductility of the magnesium alloy tested was found to be considerably less under biaxial tension than under simple tension. The modulus of elasticity of simple tension was found to vary according to the relation $E = Ae^{Q/RT}$, where $E$ is the modulus of elasticity, $T$ is the absolute temperature, $e$ is the base for natural logarithms and $A$, $Q$, $R$ are material constants.

**Strength of Bent Copper Tube.** G. S. Sangdahl, Jr. and W. M. Baldwin, Jr., Case Institute of Technology.

It is the general belief that copper tubes are weakened by bending, due to a thinning of the wall thickness. This investigation was undertaken to provide evidence that, in spite of this thinning of the wall, the bursting strength of a copper tube is not impaired by bending. Annealed copper tubes of diameters ranging from ⅜ to 1 ⅜ in. and in two wall thicknesses were tested. An equation has been derived which fits the conditions of draw bending and gives the bending strains in terms of the bend radius.

**Factors Affecting the Forming Properties of Several Copper Alloys in Strip Form.** John T. Richards and Ellsworth M. Smith, Penn Precision Products, Inc.

Bend, tension, and hardness tests were performed on beryllium copper, phosphor bronze, brass, nickel silver, and chromium copper strip to determine relative forming characteristics. Formability is expressed as the minimum safe radius for cold forming a 90-deg bend. The effects of composition, temper, thickness, grain size, and grain direction are considered. This investigation supplements earlier work on the forming properties of spring materials.

**Effect of Specimen Dimensions on High Temperature Mechanical Properties.** Paul Shahinian and Joseph R. Lane, Naval Research Laboratory.

**Report of Committee B-1 on Wires for Electrical Conductors.** D. Halloran, Chairman.

**Report of Committee B-5 on Copper and Copper Alloys, Cast and Wrought.** G. H. Harnden, Chairman.

**Appendix:**

**A Hardness Conversion Table for Copper-Beryllium Alloy Strip.** G. R. Gohn, Bell Telephone Laboratories, Inc.

A hardness conversion table is given for copper-beryllium alloy strip ranging in thickness from 0.010 to 0.064 in. For material in the "as rolled" condition having a tensile strength within the range of 70,000 to 132,000 psi, conversion values, based upon material having the same tensile strength, are given for diamond pyramid hardness numbers taken with both a 2 ½ and a 5-kg load, the Rockwell B, and the Rockwell Superficial 30T scales. For precipitation-hardened material having a tension strength within the range of 106,000 to 192,000 psi, conversion values are given for the diamond pyramid hardness numbers taken with both a 2 ½- and a 5-kg load, the Rockwell C, and the Rockwell Superficial 30N scales.

## Tuesday, June 28 12:00 noon Seventh Session

## Luncheon Session—President's Address, 40- and 50-Year Members, Awards of Merit, Introduction of New Officers

[To be held in air-conditioned Vernon Room, Haddon Hall]

## Tuesday, June 28 2:30 p.m. Eighth Session

## Session on Steel

**Effect of Strain Rate-History on the Creep Behavior of an Alloy Steel at 800 F.** H. A. Lequear and J. D. Lubahn, General Electric Co.

Two groups of tests were made on a heat-treated Cr-Mo-V steel at 800 F. In one group most of a 0.3 per cent plastic prestrain was introduced in about 15 days on the average, and in the other group the same strain was introduced in only 40 min on the average. Then both groups were brought to a common stress. The quickly strained specimens had about 30 times the creep rate of the slowly strained specimens immediately after being brought to the common stress. This very definite rate-history effect is in such a direction that strain aging would account for it, whereas the direction of the effect is opposite to what one would expect from earlier experiments by Dorn. Interrupted creep tests failed to reveal any strain aging effects that could explain the observed rate-history effect.

**Effects of Neutron Irradiation in Steels.** J. C. Wilson and R. G. Berggren, Oak Ridge National Laboratory.

The effects of irradiation in nuclear reactors on strength and ductility of a number of carbon, low alloy, and stainless steels are described and present knowledge is summarized. The possible need for additional ASTM specifications for steels subjected to neutron irradiation during service is discussed since testing of irradiated metals has disclosed peculiarities of behavior.

The accepted relationships between mechanical test results and service performance may need to be modified for metals subjected to neutron irradiation.

**Effect of Time and Temperature on Impact and Tensile Properties of Hot-Rolled Low Carbon Steels During Strain Aging.** F. Garofalo, G. V. Smith, and D. C. Marsden, United States Steel Corp.

Straining and aging of hot-rolled low-carbon steels at 75 or 450 F brings about a pronounced shift to higher temperatures in the notch-impact transition-temperature range. The maximum shift after aging at 75 F is similar for a silicon-aluminum killed steel made by the liquid metal process, a capped open-hearth steel, and a capped bessemer steel. After fully aging at 75 F and aging additionally at 450 F only the bessemer steel shows an additional shift. No over-aging at 75 or 450 F is found. Exposure at 900 or 1200 F brings about a slight improvement in notch impact properties, whereas normalizing brings about complete recovery. Little

recovery in tensile properties is found upon extended aging at 75 F. Somewhat more is found upon aging at 450 F and a great deal more is observed on exposure at 900 or 1200 F.

**An Investigation of the 21 Per Cent Chromium–10 Per Cent Nickel Heat-Resistant Alloy.** R. J. Mangone, D. D. Burgan, and A. M. Hall, Battelle Memorial Institute.

An investigation was made of the effect of composition on the microstructure and mechanical properties of the 21 Cr-10 Ni heat-resistant casting alloy. The composition variables studied included nickel, chromium, carbon, and nitrogen.

Though essentially austenitic, the alloy can contain ferrite or sigma under certain circumstances. The probability that ferrite can be formed is increased when the chromium content is high, and the nickel content or the carbon content low. A formula relating austenite-ferrite balance to composition is proposed. Evidence suggesting that ferrite-containing compositions are susceptible to sigma formation is given. Excess carbon is disposed as eutectic carbides; secondary carbides can be precipitated at intermediate temperatures such as 1400–1500 F; agglomeration and spheroidization of carbides occur at temperatures of 1900 F and above.

Data are given on room-temperature and short-time elevated-temperature tensile properties. Stress-rupture properties at 1200, 1400, and 1600 F are given. Carbon was shown to be a potent strengthener. Some data are included which support field experience that this alloy has high-temperature strength properties comparable with those of the 26 Cr-12 Ni casting alloy.

Excellent resistance to thermal-fatigue cracking was observed. Improvements in this property were made when the excess carbides were spheroidized by a pretreatment at 1900 F. The average linear coefficient of thermal expansion between 80 and 1600 F was found to be about $10.5 \times 10^{-6}$ in. per in. per deg Fahr.

## Tuesday, June 28 4:30 p.m. Ninth Session

Held simultaneously with the Tenth Session

### Committee Report Session

**A-5 on Corrosion of Iron and Steel.** A. P. Jahn, Chairman.

**A-6 on Magnetic Properties.** A. C. Beiler, Chairman.

**B-2 on Non-Ferrous Metals and Alloys.** Bruce W. Gonser, Chairman.

**B-4 on Metals for Electrical Heating, Electrical Resistance, and Electronic Applications.** S. A. Standing, Chairman.

**B-8 on Electrodeposited Metallic Coatings.** C. H. Sample, Chairman.

**B-9 on Metal Powders and Metal Powder Products.** J. L. Bonano, Chairman.

**E-7 on Non-Destructive Testing.** J. H. Bly, Chairman.

## Tuesday, June 28 4:30 p.m. Tenth Session

Held simultaneously with the Ninth Session

### Committee Report Session

**C-2 on Magnesium Oxychloride and Magnesium Oxysulfate Cements.** D. S. Hubbell, Chairman.

**C-20 on Acoustical Materials.** H. A. Leedy, Chairman.

**D-16 on Industrial Aromatic Hydrocarbons and Related Materials.** D. F. Gould, Chairman.

**D-17 on Naval Stores.** V. E. Grotlisch, Chairman.

**E-5 on Fire Tests of Materials and Construction.** A. L. Brown, Chairman.

## Tuesday, June 28 5:00 p.m. Eleventh Session

### Gillett Memorial Lecture

**Powder Metallurgy—Now (New Techniques, Improved Properties, Wider Use)** Fritz V. Lenel, Associate Professor, Department of Metallurgical Engineering, Rensselaer Polytechnic Inst.

This Lecture, established in 1951, is jointly sponsored by ASTM with Battelle Memorial Institute. It commemorates Horace W. Gillett, one of America's leading technologists and metallurgists and the first Director of Battelle. The Lecture is delivered annually at a meeting of the Society, the first one having been given at the Fiftieth Anniversary Meeting, June, 1952. The Lecture will cover subjects pertaining to the development, testing, evaluation, and application of metals.

**[To be held in air-conditioned Vernon Room, Haddon Hall]**

## Tuesday, June 28 8:00 p.m. Twelfth Session

Held simultaneously with the Thirteenth Session

### Session on Significance of Tests of Concrete

**Resistance of Concrete to Fire and Radiation (Including Jet-Aircraft Blast).** Perry H. Petersen, U. S. Naval Civil Engineering Research and Evaluation Laboratory.

The significance of this type of test is difficult to delineate at the present time, since the research being performed in this field by the various investigators has not been too well integrated; the conditions of exposure have not been agreed upon nor is it probable that they ever will be standardized even for instances of blast and heat simulating those encountered in the use of jet aircraft. The author has attempted to present an indication of the degree of exposure which may be realized under actual field conditions, the type of deterioration which occurs, and the method of attack suggested for an analysis of the problem. Particular attention is given to the degree of exposure encountered in the use of a jet engine with and without afterburner; this immediate and high-temperature attack on concrete is contrasted to the relatively slow build-up of temperature typified in the standard building construction fire-resistance curve.

**Basic Considerations Pertaining to The Freezing and Thawing Test.** T. C. Powers, Portland Cement Assn.

Questions about current test methods are raised and an alternative test suggested. Preparatory to this, knowledge about the mechanisms of frost action in hardened paste and in rock is summarized. Emphasis is placed on concepts of critical thickness and critical saturation, and the roles of air bubbles in paste and macropores in absorptive rock. Rapid freezing in the laboratory may destroy concrete that is immune to frost under natural conditions. Also, important effects of seasonal drying are not taken into account. A new procedure is proposed that takes category of field exposure into account, and uses period of immunity to frost attack as the primary measure of frost resistance.

**Needed Research on Concrete and Concrete Aggregates.** A. T. Goldbeck, National Crushed Stone Assn.

**Static and Fatigue Strength of Concrete.** Clyde E. Kesler and Chester P. Siess, University of Illinois.

In this concise discussion of the static and fatigue strength of concrete, emphasis is placed on the methods of tests and the significance of the results obtained. Tests for determining compressive, tensile, and shear strength are discussed as well as combined stresses. Various procedures for manufacturing test specimens are evaluated and emphasis placed on those procedures where slight differences may make considerable differences in the results. Fifty selected references include the important papers connected with the testing of concrete for static and fatigue strength.

## Tuesday, June 28 8:00 p.m. Thirteenth Session

Held simultaneously with the Twelfth Session

## Symposium on High Purity Water Corrosion

**Report of Committee D-19 on Industrial Water.** Max Hecht, Chairman.

**Max Hecht Award.**

**Report of Committee E-10 on Radioactive Isotopes.** G. D. Calkins, Chairman.

***Symposium on High Purity Water Corrosion***

**Methods of Preparing and Maintaining High Purity Water.** F. N. Alquist, Dow Chemical Co.

**Effect of Material Composition in High Temperature Water Corrosion.** A. H. Roebuck, Continental Oil Co.

The corrosion resistance of metals is directly related to their composition and constituent distribution.

In high-temperature water, metallic materials having high corrosion resistance include: austenitic stainless steel, precipitation hardening stainless steels, cobalt alloys, gold, platinum, titanium, zirconium, and hafnium. The composition of these materials gives rise to chemical mobility or the formation of insoluble highly resistant oxide coating films. Materials of intermediate corrosion resistance include: aluminum and aluminum alloys, chromium, 70-30 copper-nickel, cobalt, ferritic and martensitic stainless steels, nickel and nickel alloys. Under conditions where dissolved oxygen has been removed, nickel and nickel alloys show high corrosion resistance.

Of the factors remaining to be studied, the correlation of composition and constituent distribution to passivity and resistant oxide film formation deserves special consideration.

**Special Study of Carbon and Low Alloy Steels.** R. U. Blaser, The Babcock & Wilcox Co.

The usual applications of carbon steel and low alloys in boilers, heat exchangers, and other equipment containing water at elevated temperatures are based on water treatment designed to reduce corrosion. In much new equipment for special applications such as nuclear reactor systems, once-through boilers, etc., pure water is an important requirement. An extreme minimum of added chemicals for water treatment is permissible. Determination of quantitative corrosion data and studies of other problems related to the use of carbon steel and low alloys in such environments are reported.

Description of water conditions and apparatus for high velocity and static tests up to 750 F, 3500 psi, quantitative data, and metallographic and visual observation of specimens are included. Water conditions are based on de-aerated, de-oxygenized, distilled water. Small quantities of gas or chemical treatment are added for certain work. Tests of specimens for various lengths of time approaching one year permit estimates of initial corrosion rates decreasing with continued exposure to the test environment.

**Effect of Various Water Environments.** D. Wroughton, Westinghouse Electric Corp.

**Reactor Water Supply.** H. W. Huntley and S. Untermyer, General Electric Co.

Requirements for condenser cooling, boiler feedwater, and primary cooling water are discussed. Standard practices can be used for condenser cooling water or boiler feedwater but especially pure water is required for use within the reactor. Considerations based on radioactive nature of the effluent are presented. The extent of radioactivity to be experienced within the turbine of a boiling reactor is calculated and conclusions based on these calculations are presented.

## Wednesday, June 29 9:30 a.m. Fourteenth Session

Held simultaneously with the Fifteenth Session

## Symposium on Atmospheric Corrosion of Non-Ferrous Metals

The authors of the papers comprising this symposium are combining reports of their own private work on the atmospheric corrosion of non-ferrous metals and that of Subcommittees VI and VIII of ASTM Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys. It is hoped that the information obtained in the 20-year exposure of various non-ferrous metals and alloys, and the recently completed tests of galvanic couples combined with the private work reported, will be useful in the proper selection of materials for atmospheric exposure.

At the ASTM Spring Meeting held in Pittsburgh, Pa., on February 27, 1946, the results of the first ten years of the B-3 Sub. VI tests were described in a symposium. The present symposium supplements the other by adding the work indicated above, the results of private investigations, and the present viewpoints of the authors whose experience has been greatly extended during the intervening years.

Messrs. Reinhart and Ellinger are presenting the work of the Bureau of Standards on aluminum alloys which paralleled that of B-3 but at a different location. Mr. Thompson presents the work of the American Brass Co. on the atmospheric corrosion of various types of copper in both similar environments and for a comparable length of time to that of B-3. The other authors are men well acquainted with the work of B-3 and with the corrosion behavior of the metals covered in their papers. They have contributed observations of their own to make their papers well rounded.

**The Resistance of Aluminum-Base Alloys to 20 Year Atmospheric Exposure.** C. J. Walton and William King, Aluminum Company of America.

This paper comprises a discussion of the 20-year atmospheric weathering data obtained on wrought aluminum-base alloys included in an investigation on non-ferrous metals sponsored by ASTM Committee B-3. The pertinent data obtained after exposure periods of 1, 3, 6, 10, and 20 years have been tabulated and also arranged graphically to illustrate characteristics of specific interest, such as (1) effect of natural aging on the tensile strength of specimens stored indoors for 20 years; (2) rating of the corrosivity of the seven atmospheric conditions employed; and (3) the rate of weathering of the five aluminum alloys. These important data have been further enhanced by correlating them with equally long-time data obtained by the Aluminum Research Laboratories on similar alloys in other atmospheric environments, and on newer aluminum alloys which now complement or supersede the alloys which had been in the ASTM investigation.

**Effect of Marine and Urban Atmospheres on Aluminum Alloys.** Fred M. Reinhart and G. A. Ellinger, National Bureau of Standards.

The results of the exposure of approximately 7000 specimens of 18 different aluminum alloys for 22 years in a marine atmosphere at Hampton Roads, Va., and an urban atmosphere in Washington, D. C., are reported. The effect of heat treatments, surface treatments, and paints on the corrosion resistance of these alloys is evaluated by surface conditions and by changes in tensile properties.

**Effect of Natural Atmospheres on Copper Alloys—20 Year Test.** A. W. Tracy, The American Brass Co.

This paper discusses the corrosion resistance of eleven coppers of widely differing types exposed to industrial, marine, and rural atmospheres over a period of 20 years. The evaluation of corrosion rates of the several metals is based on weight loss measurements and changes in mechanical properties of sheet specimens.

**Atmospheric Corrosion of Copper—Results of 20 Year Test.** D. H. Thompson, A. W. Tracy, and John R. Freeman, Jr., The American Brass Co.

Eleven brands of copper, in the form of sheet and wire, have been exposed for 20 years to four outdoor atmospheres in Connecticut. The effect of corrosion has been evaluated by loss in weight, loss in strength, and gain in electrical resistance. Some of the results have been examined by applying an analysis of variance.

**Report of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys.** K. G. Compton, Chairman.

**Advisory Committee on Corrosion.** F. L. LaQue, Chairman.

*(Continued in the Seventeenth Session)*

## Wednesday, June 29 9:30 a.m. Fifteenth Session

Held simultaneously with the Fourteenth Session

### Session on Concrete

**A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity.** Carl A. Menzel, Portland Cement Assn.

When hardened concrete is exposed to the air its moisture content tends to attain a state of balance or equilibrium with the relative humidity of the air. Changes in moisture content may be important in various ways and it is often desirable to have definite information on the moisture condition of the hardened concrete in block, walls, floors, or other building members.

This paper describes a rapid method and simple apparatus for determining the moisture condition of hardened concrete and expressing the results directly in terms of relative humidity—the basic factor controlling the moisture content of air-dry concrete.

This method can also be used to determine the moisture condition of other construction materials and assemblies affected by relative humidity.

**Osmotic Studies and Hypothesis Concerning Alkali-Aggregate Reaction.** George Verbeck and Charles Gramlich, Portland Cement Assn.

An osmotic cell technique for the study of the chemistry and physics of the alkali-aggregate reaction is described. Application of the experimental results has led to the development of a hypothesis concerning the reaction of alkalies in concrete or mortar with reactive siliceous aggregates.

The hypothesis considers that the nature of the reaction product formed, whether deleterious or innocuous, is dependent upon the relative availability of the alkali and calcium hydroxide to the area of the reactive surface.

The influence of various factors upon the relative availabilities of alkali and calcium hydroxide, such as the inherent properties of cement paste, alkali concentration and particle size, and quantity of aggregate, are discussed. The mobilities of the alkali and calcium hydroxide are presumably not independent and each is affected by the permeability of the paste, the size of the hydrated ion complex, and possibly electrokinetic phenomena.

**Effect of Depth of Beam upon Modulus of Rupture of Plain Concrete.** C. P. Linder and J. C. Sprague, Corps of Engineers.

The load at failure of concrete beams does not vary as the conventionally visualized square of the depth, and the modulus of rupture of concrete varies inversely with depth. An attempt is made to rationalize this behavior and to point out some of its ramifications. An equation, termed the "rectibolic formula," is offered for measuring the tensile stress. Its solution yields results that approach more closely than does the conventional formula to the true breaking strength of concrete subjected to bending stresses. Measurements of the location of the neutral axis are presented, the position of which is consistent with reduction in relative load-bearing capacity for increased depth of beam.

**Report of Committee C-9 on Concrete and Concrete Aggregates.** W. H. Price, Chairman.

**Sanford E. Thompson Award.**

**Report of Committee C-13 on Concrete Pipe.** R. R. Litehiser, Chairman.

## Wednesday, June 29 11:30 a.m. Sixteenth Session

### Committee Report Session

**C-3 on Chemical-Resistant Mortars.** Beaumont Thomas, Chairman.

**C-19 on Structural Sandwich Constructions.** E. W. Kuenzi, Chairman.

**D-5 on Coal and Coke.** W. W. Anderson, Chairman.

**D-7 on Wood.** L. J. Markwardt, Chairman.

**D-8 on Bituminous Waterproofing and Roofing Materials.** H. R. Snoke, Chairman.

**D-9 on Electrical Insulating Materials.** A. H. Scott, Chairman.

**D-14 on Adhesives.** R. F. Blomquist, Chairman.

**D-18 on Soils for Engineering Purposes.** E. J. Kilcawley, Chairman.

## Wednesday, June 29 2:00 p.m. Seventeenth Session

Held simultaneously with the Eighteenth Session

### Symposium on Atmospheric Corrosion of Non-Ferrous Metals (*Continued*)

**Atmospheric Galvanic Corrosion of Dissimilar Metal Couples.** H. O. Teeple, The International Nickel Co., Inc.

This paper presents the first results of a portion of a test program sponsored by the ASTM Committee B-3, Sub-Committee VIII. The portion of the test program to be covered by this paper concerns the atmospheric galvanic corrosion of dissimilar metals using a disk-type couple arrangement.

Results are presented for the following materials exposed in quadruplicate in several combinations: magnesium AZ31X, magnesium M1, mild steel, 70-30 brass, 24 ST aluminum, 75 ST aluminum, 56 S aluminum, 2 S aluminum, stainless steel (Type 304), monel, nickel, zinc, cadmium plated steel, and zinc plated steel.

The results are based upon weight-loss measurements which are augmented by visual observations of the type and extent of attack. Photographs of the exposed specimens will also be included.

**Galvanic Couple Corrosion Studies by Means of the Threaded Spool and Wire Test.** K. G. Compton and A. Mendizza, Bell Telephone Laboratories, Inc.

Various galvanic couples have been exposed to rural, marine, and industrial atmospheres in the form of a wire wound around a threaded spool. The results indicate that the method provides a rapid means of determining relative galvanic corrosion rates. In the ASTM tests exposures were made for three 4-month periods and a 1-year period. Materials tested include magnesium and aluminum alloys, zinc, and brass. Other data are included from tests run independently of the ASTM program. In addition to the relative rates of galvanic couple corrosion obtainable by this method, specimens of this type can be used to calibrate the corrosiveness of various sites. As an indication of the sensitivity of the method, weight losses greater than 5 per cent were observed in magnesium alloy wires.

**The Atmospheric Corrosion of Rolled Zinc.** E. A. Anderson, The New Jersey Zinc Co. (of Pa.).

On the basis of useful weight change data from atmospheric exposures extending over a 20-year period, it is concluded that the corrosion rate of rolled zinc varies with the degree of industrial contamination in the atmosphere and is essentially constant over this time interval. The increased corrosion rate in heavily industrialized atmospheres is related to the known effect of the pH of water on the corrosion of zinc. Slow drying of moisture films results in increased corrosion activity by permitting rapid oxidation of hydrogen barrier films which the high hydrogen overvoltage of zinc causes to form.

**The Behavior of Lead, Tin, and Antimonial Lead in the Outdoor Atmosphere.** George O. Hiers, Consulting Metallurgist.

**Atmospheric Corrosion Behavior of Some Nickel Alloys.** H. R. Copson, The International Nickel Co., Inc.

The atmospheric corrosion behavior of nickel, nickel-copper alloys, nickel-iron alloys, nickel-chromium alloys, and some nickel-iron-chromium alloys, including some stainless steels, is discussed. Much of the data were obtained at an industrial test site at Bayonne, N. J. The data on monel and nickel obtained by Subcommittee VI of ASTM Committee B-3, on Corrosion of Non-Ferrous Metals and Alloys in industrial, marine, and rural atmospheres is included. Weight losses, pit depths, and losses in strength are reported. The effect of location, shelter, time, and other exposure conditions is discussed.

## Wednesday, June 29 2:00 p.m. Eighteenth Session

Held simultaneously with the Seventeenth Session

## Symposium on Speed of Testing

Much has been said and written about the effect of speed of testing on ferrous and nonferrous materials, but there is an appalling lack of reliable data on the effect of testing speed on most nonmetallic materials. Here the field of operation is wide because of the tremendous variability in the response of glass on one hand and rubber on another.

This symposium is only a start toward filling this void. The testing speeds employed encompass very slow to very fast straining rates. The accumulation of data does not represent the last word on the subject. There is much more work to be done but this will establish a foundation upon which to build further.

**Effect of Speed of Testing on Tensile Strength and Elongation of Paper.** Ralph E. Green, Thwing-Albert Instrument Co.

Tensile strength and elongation of paper are affected by: specimen length, specimen width, edge effects, temperature-humidity, and speed of testing.

This paper deals with the effect of speed of testing only. The first four are more or less elementary and have been noticed by almost every technician interested in reducing variation within a test. The specimens tested were chosen because they are subjected to tensile forces at varying speeds during their periods of usefulness. In these five papers, tensile strength and elongation are important factors in predicting performance.

**Effect of Speed in Plastics Testing.** F. S. McGarry and Albert G. H. Dietz, Massachusetts Institute of Technology.

Recent developments in the field of plastics testing at various rates are reviewed with respect to apparatus, techniques, material properties, and results. As the awareness of speed effects in materials testing becomes more widespread, increased work in all of these fields is being pursued with the consequence that interesting developments are occurring at a gratifying rate. What are considered to be the more important of these are covered in some detail, while other not directly related to the topic of plastics testing are mentioned.

**The Influence of Rate of Loading on the Strength of Wood and Wood-Base Materials.** L. J. Markwardt and J. A. Liska, U. S. Forest Products Laboratory.

That the strength properties of wood and wood-base materials are influenced by duration of stress has long been recognized, both in the use of design stresses and through the establishment of rate of loading requirements in standard test methods. Extensive data have been obtained on the effect of rate of loading on the compression-parallel-to-grain and flexural strength properties of two hardwood and two softwood species. The similarity of trends obtained from short-time and long-time tests indicate that the relationship between ultimate strength and time can be presented in a simple curve from load durations of a fraction of a second to many years. Moduli of elasticity values remain substantially constant irrespective of loading time.

Data are presented to show that the flexural strengths of fiber building boards of the densities tested are also increased as the time of loading is increased. Further tests are necessary, however, to establish more precisely the magnitude of this effect for fiberboards. Additional studies are needed further to determine the influence of rate of loading on other of the mechanical properties, both for wood and wood-base materials, and to provide more substantial data on the effect of extended long-time loading covering many years' duration.

**Stress-Strain Relationships in Yarns Subjected to Rapid Impact Loading.** Herbert F. Schiefer, Jack C. Smith, and Frank L. McCrackin, National Bureau of Standards.

Equipment will be described for elongating yarns by impact at velocities ranging from about 1000 to 20,000 feet per min. The rate of straining at impact varies from about 100,000 to 500,000 per cent per min. A procedure will be discussed for obtaining load-elongation curves for loading and for unloading of the specimen and for loading to rupture in a time interval of only a few milliseconds. Mathematical analyses will be discussed for Hookean and visco-elastic behavior of the material during impact and for obtaining critical velocity and energy to any strain, including maximum and rupture strains. The importance of stress and strain propagation will be indicated. Results of tests on different materials will be presented and compared with those computed from theory. The practical application of the results will be discussed.

**Effect of Speed in Mechanical Testing of Concrete.** J. J. Shideler and Douglas McHenry, Portland Cement Assn.

The paper reviews current specifications on rate of loading of concrete and mortar test specimens, and presents data from various sources on the effect of speed of testing on compressive strength, flexural strength, and modulus of elasticity of concrete. In general, higher rates of loading show higher strengths in compression and flexure; modulus of elasticity also appears to increase with loading rate, although most observers have attributed this effect to reduced creep during the test period. An annotated bibliography is included.

**Effect of Speed of Testing on Tension Test of Elastomers and Hard Rubber.** D. C. Scott, Jr., Scott Testers, Inc., and D. S. Villars, U. S. Naval Ordnance Test Station.

A review of the investigations involving the effect of speed of testing on the tension test of elastomers and hard rubber. It is concluded that, for elastomers in the range of the standard Scott tension test (20 in. per min or 0.03 per cent per millisecond), the elongation rate usually has little effect. At speeds above 4 per millisecond, however, the test results are altered. For elastomer stocks which crystallize, tensile strength is independent of speed until one exceeds rates too fast for crystallization to occur, after which point there is a drop in tensile strength. Above elongation rates of about 10 per cent per millisecond. tensile strength increases as slipping contacts get less chance to relax. For hard rubber, increasing speed seems to increase tensile strength even at low speeds.

**The Effect of Speed of Testing on Glass.** H. N. Ritland, Corning Glass Works.

There are a number of time-dependent processes which occur in glass and which affect testing procedures. In this review two of these processes which are of particular importance in this respect are discussed–the structural changes which are of importance at annealing temperatures and the surface effects which give rise to delayed fracture at ordinary temperatures. The experimental evidence which indicates that this latter effect is caused by the slow growth of microscopic surface cracks is also reviewed.

**Report of Committee E-1 on Methods of Testing.** J. R. Townsend, Chairman.

## Wednesday, June 29 4:00 p.m. Nineteenth Session

Held simultaneously with the Twentieth Session

## Committee Report Session

**A-1 on Steel.** H. B. Oatley, Chairman.

**A-7 on Malleable-Iron Castings.** W. A. Kennedy, Chairman.

**A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys.** Jerome Strauss, Chairman.

**B-6 on Die-Cast Metals and Alloys.** W. Babington, Chairman.

**C-11 on Gypsum.** G. W. Josephson, Chairman.

**E-3 on Chemical Analysis of Metals.** Arba Thomas, Chairman.

**E-4 on Metallography.** L. L. Wyman, Chairman.

**E-6 on Methods of Testing Building Constructions.** R. F. Legget, Chairman.

## Wednesday, June 29 4:00 p.m. Twentieth Session

Held simultaneously with the Nineteenth Session

### Committee Report Session

**D-1 on Paint, Varnish, Lacquer, and Related Products.** W. T. Pearce, Chairman.

**D-12 on Soaps and Other Detergents.** J. C. Harris, Chairman.

**D-13 on Textile Materials.** W. D. Appel, Chairman.

**D-21 on Wax Polishes and Related Material.** W. W. Walton, Chairman.

**D-23 on Cellulose and Cellulose Derivatives.** F. A. Simmonds, Chairman.

**E-11 on Quality Control of Materials.** H. F. Dodge, Chairman.

**E-12 on Appearance.** M. Rea Paul, Chairman.

## Wednesday, June 29 4:30 p.m. Twenty-first Session

### Marburg Lecture, Dudley Medal, and Awards

**Marburg Lecture—A Technology for the Analysis, Design, and Use of Textile Structures as Engineering Materials.** W. J. Hamburger, Director, Fabric Research Laboratories, Inc.

The purpose of the Edgar Marburg Lecture is to have described at the annual meetings of the Society, by leaders in their respective fields, outstanding developments in the promotion of knowledge of engineering materials. Established as a means of emphasizing the importance of the function of the Society of promoting knowledge of materials, the Lecture honors and perpetuates the memory of Edgar Marburg, first Secretary of the Society, who placed its work on a firm foundation and through his development of the technical programs brought wide recognition to the Society as a forum for the discussion of properties and tests of engineering materials.

**Charles B. Dudley Medal**

**Richard L. Templin Award**

**[To be held in air-conditioned Vernon Room, Haddon Hall]**

## Wednesday, June 29

## Cocktail Party 6:30 p.m.

## ANNUAL DINNER 7:30 p.m.

### Entertainment

**[To be held in air-conditioned Vernon Room, Haddon Hall]**

## Thursday, June 30 9:30 a.m. Twenty-Second Session

Held simultaneously with the Twenty-Third Session

### Panel on Pyrometry

A Panel Session on Pyrometric Practice in Elevated Temperature Testing, sponsored by the Joint ASTM-ASME Committee on the Effects of Temperature on the Properties of Metal was organized by the Test Methods Panel, J. J. Kanter, chairman, and is concerned with the ASTM recommended practices on high temperature testing of metals, E 21, E 22, and E 85. Much interest centers in defining the precision of temperature measurement and control which can be recommended or specified in high-temperature test work. The panel session is organized for the presentation and discussion of work in this field. One formal paper will be presented. Discussion leaders of the panel will include Arnold M. Bass of Temperature Measure Section, U. S. Bureau of Standards, P. H. Dike, Leeds & Northrup Co. and J. R. Freeman, University of Michigan, who has compaigned persistently in the Joint High-Temperature group for a rationale of temperature measurement in creep and rupture testing.

**Some Sources of Error in Temperature Measurement Arising from Thermocouple "Immersion" Effects.** J. M. Berry and D. L. Martin, General Electric Research Laboratory.

An attempt has been made to distinguish between two types of "immersion" effects. The first type occurs when an inhomogeneous portion of a thermocouple (developed, perhaps, at the service temperature) is subjected to a temperature gradient. The second type of immersion error is related to conduction of heat to or from the hot junction of the thermocouple. Both of these immersion errors are directly related to the thermocouple material and its temperature surroundings. Poorly operating control and measuring systems will not cause these errors, nor will the best instrumentation reveal them.

## Thursday, June 30 9:30 a.m. Twenty-Third Session

Held simultaneously with the Twenty-Second Session

## Session on Fatigue

**Observations on the Mechanism of Fatigue Damage.** R. G. Crum and E. D'Appolonia, Carnegie Institute of Technology.

Fatigue specimens stressed above the linear-elastic range behave elastically for a part of their finite life. During the early stages of repeated loading the dynamic mid-span deflection is not plastic. Depending upon the stress level, a number of cycles of repeated load must be applied before the mid-span deflection attains a value equal to the plastic deflection under static load. This study was directed to establish the threshold of the damage region. Tests of overstress and understress to and beyond the threshold of damage were conducted.

**Strength, Damping, and Elasticity of Materials Under Increasing Reversed Stress with Reference to Accelerated Fatigue Testing.** F. H. Vitovec and B. J. Lazan, University of Minnesota.

Data are presented on the damping, elasticity, and fatigue properties of 24S-T4 aluminum alloy, SAE 1020 and SAE 4340 steel, and RC-55 titanium alloy, under rotating bending stress, which is (1) constant for a given specimen, and (2) which increases uniformly. The dynamic proportional limit and the damping properties under uniform stress increase are investigated to determine if these are related to the fatigue strength as proposed by Gough and Lehr, respectively. The failure stress at different rates of stress increase was determined to evaluate the reliability of the Prot method. The fatigue tests were started at various stresses below the fatigue strength to investigate the effect of starting stress on the Prot failure stress. The results indicate that the dynamic proportional limit and the linear plot of damping energy *versus* stress give no reliable indication of the fatigue strength. The Prot-short-time fatigue testing method can be applied for only certain types of materials.

**An Investigation of Strain Aging Effects in Fatigue.** J. C. Levy, Northampton Polytechnic Institute; formerly with the University of Illinois and G. M. Sinclair, University of Illinois.

The fatigue behavior of low-carbon steel was investigated at temperatures up to 700 F under conditions of constant stress amplitude. It was found that a pronounced peak occurred in fatigue life in the region of 450 F. Both the presence and magnitude of the peak appeared to depend on the amount of carbon and nitrogen in the steel. Results were analyzed in terms of a theory of strain aging in which interstitial atoms are presumed to strengthen the metal by diffusing to dislocations in the crystal lattice. When the theory was modified to suit fatigue conditions it was found that the calculated peaking temperature agreed well with the experimentally determined value.

**Understressing as a Means of Eliminating the Damaging Effect of Fatigue Stressing.** Henry E. Frankel and J. A. Bennett, National Bureau of Standards.

Rotating-beam tests of a heat-treated alloy steel showed that the fatigue limit could be increased by coaxing. The damaging effect of fatigue stressing 10 per cent above the fatigue limit was eliminated by understressing and coaxing. Damage produced by a stress 30 per cent above the fatigue limit was not completely eliminated. Specimens coated with a rust-preventive oil showed greater fatigue resistance than clean specimens.

*(Continued in the Twenty-Eighth and Thirty-Second Sessions)*

## Thursday, June 30 2:00 p.m. Twenty-Fourth Session

## Symposium on Metallic Materials for Service at Temperatures Above 1600 F

The pressing demand of engineers to attain greater efficiency in heat engines has created a need for metals to withstand the increase in operation temperatures which is demanded. Steam power plant design engineers are pushing temperatures and operating pressures beyond the safe operating limits of the ferritic steels now in use, and the gas turbine engineers—not to mention those concerned with such devices as guided missiles—are prepared to design for operation at temperatures higher than the 1600 F limit to which they have been confined for want of materials capable of satisfactorily withstanding higher temperatures of operation. What the prospects are for providing metallic materials suitable for such service furnishes the subject matter for discussion in this symposium on Metallic Materials for Service at Temperatures Above 1600 F sponsored by Subcommittee of the Research Panel of the Joint ASTM-ASME Committee on the Effect of Temperature on the Properties of Metals.

As many as possible of the properties, physical, chemical and mechanical, as well as methods of combating surface deterioration, that are affected by temperature will come up for discussion in papers to be presented to provide a basis of evaluation of a number of metallic materials, including the cermets, which have been undergoing study in laboratories both here and abroad to determine their suitability for such higher temperature service.

There are some eleven papers to be presented at the two sessions devoted to this symposium.

*(Continued in the Twenty-Seventh Session)*

## Thursday, June 30 4:30 p.m. Twenty-Fifth Session

Held simultaneously with the Twenty-Sixth Session

## Committee Report Session

**B-7 on Light Metals and Alloys, Cast and Wrought.** I. V. Williams, Chairman.

**Appendix: Atmospheric Exposure of Wrought Aluminum and Magnesium Alloys.** L. H. Adam, Frankford Arsenal.

**A-2 on Wrought Iron.** A. D. Morris, Chairman.

**E-2 on Emission Spectroscopy.** J. R. Churchill, Chairman.

**E-13 on Absorption Spectroscopy.** E. J. Rosenbaum, Chairman.

**E-14 on Mass Spectrometry.** M. J. O'Neal, Chairman.

## Thursday, June 30 4:30 p.m. Twenty-Sixth Session

Held simultaneously with the Twenty-Fifth Session

## Committee Report Session

**C-1 on Cement.** R. R. Litehiser, Chairman.

**C-8 on Refractories.** R. B. Sosman, Chairman.

**C-12 on Mortars for Unit Masonry.** R. E. Copeland, Chairman.

**C-14 on Glass and Glass Products.** L. G. Ghering, Chairman.

**C-16 on Thermal Insulating Materials.** E. R. Queer, Chairman.

**C-17 on Asbestos-Cement Products.** D. Wolochow, Chairman.

**C-21 on Ceramic Whiteware and Similar Products.** C. J. Koenig, Chairman.

**C-22 on Porcelain Enamel.** W. N. Harrison, Chairman.

**D-4 on Road and Paving Materials.** C. W. Allen, Chairman.

## Thursday, June 30 8:00 p.m. Twenty-Seventh Session

## Symposium on Metallic Materials for Service at Temperatures Above 1600 F (*Continued*)

[See summary of this symposium in Twenty-fourth Session]

**Report of Joint Committee on Effect of Temperature on the Properties of Metals.** F. B. Foley, Chairman.

## Friday, July 1 9:30 a.m. Twenty-Eighth Session

Held simultaneously with the Twenty-Ninth Session

## Session on Fatigue (*Continued*)

**The Fatigue Properties of Some Titanium Alloys.** A. W. Demmler, Jr., M. J. Sinnott, and L. Thomassen, University of Michigan.

The rotating-beam fatigue-life characteristics of three commercial alloys and two experimental alloys of titanium have been investigated. The influence of various methods of surface preparation and treatment on the fatigue life has been evaluated. Shot peening the surfaces improves fatigue life in the high stress region of the *S-N* curve while grinding adversely affects the properties in the lower stress region. Oxidizing or nitriding the surfaces markedly decreases the fatigue life. Surface finish does not appear to be an important factor in determining fatigue life. The internal heating of commercially pure titanium has been traced to the presence of hydrogen. The standard deviation of the fatigue life appears to be of the same order of magnitude as reported for other metals.

**Torsion Prestrain and the Fatigue Life of RC-55 Titanium Alloy.** J. G. Kaufman, Aluminum Company of America; formerly with Carnegie Institute of Technology, and E. D'Appolonia, Carnegie Institute of Technology.

The effect of torsional prestrain on the behavior of RC-55 titanium alloy was studied with rotating-beam fatigue tests.

Torsional prestrain ranged from 5 to 60 per cent of the torsional strain to failure. Rotating-beam notched and unnotched specimens were machined from the twisted alloy and fatigue-tested at 10,000 rpm and room temperature (70 F). Data from tests of torsionally prestrained specimens were compared with data from tests of otherwise similar specimens that had not been prestrained.

Internal heating was studied by comparing data from tests of unnotched specimens at room temperature with data from tests conducted while water circulated over the specimen.

Fatigue data from specimens prestrained in tension and torsion were compared and correlated.

**The Fatigue Properties of Wrought Phosphor Bronze Alloys.** G. R. Gohn, J. P. Guerard, Bell Telephone Laboratories, Inc., and H. S. Freynik, Riverside Metal Co.

This paper is a part of a comprehensive study of the mechanical properties of phosphor bronze alloys. It discusses the effect of cold-working on the fatigue properties of a series of eight alloys in the form of cold-rolled strip. The tin content of these alloys varied from ½ to 10 per cent. Each material was furnished with two ready-to-finish grain sizes and six different tempers. The tempers studied include annealed, half-hard, hard, extra-hard, spring, and extra-spring. Data are also included on the 3, the 4, and the 5 per cent tin alloys to show the effect of a higher phosphorus content. Electrolytic tough pitch copper strip similarly treated is included to provide a base for evaluating the effectiveness of the tin additions.

**Effect of Alloy Content on the Metallographic Changes Accompanying Fatigue.** M. S. Hunter and W. G. Fricke, Jr., Aluminum Company of America.

The microstructural changes accompanying fatigue action have been followed for a series of binary aluminum-magnesium alloys. It is shown that the alloy addition is responsible for marked changes in the microscopically observed deformation and progressive failure, there being a gradual transition with increasing solute concentration from the behavior typical of pure aluminum to that typical of the structural aluminum alloys. Displacement of the curves of progressive change by the alloy addition are shown, as well as displacement of the *S-N* curve denoting failure.

The amount of fatigue deformation observed on the surface of a specimen proves to be a two-part exponential function of the number of test cycles. Quantitative results are given, showing how the amount of deformation is related to the stress, cycles, and alloy content.

**Axial Stress Fatigue Strengths of Several Structural Aluminum Alloys.** F. M. Howell and J. L. Miller, Aluminum Company of America.

The efficient use of materials for applications involving repeated axial loading in tension or compression requires some knowledge of their behavior under such conditions. The fact that there are many combinations of maximum and minimum stress and number of cycles to be withstood and the additional fact that no two lots of material behave exactly the same necessitates making a fairly large number of tests of different lots of material.

The paper presents the results of tests of a number of lots of CM41A-T6 (2014-T6), CG42A-T4 (2024-T4), GS11A-T6 (6061-T6), and ZG62A-T6 (7075-T6) aluminum alloys and shows how the results of tests at six ratios of minimum to maximum stress are used to reinforce each other through the construction of modified Goodman diagrams. These diagrams provide a basis for final tabulations of average or typical fatigue strengths.

(*Continued in the Thirty-Second Session*)

## Friday, July 1 9:30 a.m. Twenty-Ninth Session

Held simultaneously with the Twenty-Eighth Session

## Session on Effect of Temperature

**Thermal Shock Testing of High Temperature Metallic Materials.** Thomas A. Hunter, University of Michigan.

**Some Thermal and Mechanical Properties of Inconel to High Temperatures for Use in Aerodynamic Heating Research.** William J. O'Sullivan, Jr., Langley Aeronautical Lab.

**Correlations of High Temperature Creep Data.** Oleg D. Sherby and John E. Dorn, University of California

**The Compression Creep Properties of Several Metallic and Cement Materials at High Temperature.** L. A. Yerkovich and G. J. Guarnieri, Cornell Aeronautical Laboratory, Inc.

**Tension Testing Apparatus for the Temperature Range of −320 to −452 F.** E. T. Wessel, Westinghouse Electric Corp.

Mechanical testing at low temperatures is making important contributions to research and practical engineering studies. A necessary prerequisite to this work is the design and development of suitable testing equipment. A new apparatus which facilitates tension testing at any temperature in the range from −320 to −452 F is described. The various factors involved in testing at these very low temperatures are much more complex than those for higher temperatures, and considerable attention is given to the basic design features, the minimization of refrigerant consumption, and the interrelated aspects of temperature measurement and control. Automatic regulation of the flow of the liquid helium refrigerant is employed to reach and maintain the desired testing temperature. The vaporized refrigerant conveniently serves as the testing medium. The calculated and measured performance characteristics are also discussed.

**An Axial Loading Creep Machine.** M. H. Jones and W. F. Brown, Jr., Lewis Flight Propulsion Laboratory.

The paper describes a new lever-loading creep machine, employing special grips designed to reduce the eccentricity in testing to a minimum. Using this machine with buttonhead specimens it is possible to reduce the maximum elastic bending stresses in a 0.25 in. diameter specimen to values less than 2 per cent of the average stress. The eccentricities obtainable with this design are compared with those encountered in conventional creep machines and various factors affecting the axiality of loading are discussed. In addition, a description of the temperature control circuits used by the NACA is given.

## Friday, July 1 11:30 a.m. Thirtieth Session

Held simultaneously with the Thirty-First Session

### Committee Report Session

**D-2 on Petroleum Products and Lubricants.** O. L. Maag, Chairman.

**D-3 on Gaseous Fuels.** L. T. Bissey, Chairman.

**D-6 on Paper and Paper Products.** W. R. Willets, Chairman.

**D-10 on Shipping Containers.** G. E. Falkenau, Chairman.

**D-11 on Rubber and Rubber-Like Materials.** Simon Collier, Chairman.

**D-15 on Engine Antifreezes.** H. R. Wolf, Chairman.

**D-20 on Plastics.** R. K. Witt, Chairman.

## Friday, July 1 11:30 a.m. Thirty-First Session

Held simultaneously with the Thirtieth Session

### Committee Report Session

**A-3 on Cast Iron.** H. W. Stuart, Chairman.

**C-7 on Lime.** J. A. Murray, Chairman.

**C-15 on Manufactured Masonry Units.** J. W. Whittemore, Chairman.

**D-22 on Methods of Atmospheric Sampling and Analysis.** L. C. McCabe, Chairman.

## Friday, July 1 1:30 p.m. Thirty-Second Session

### Session on Fatigue (*Continued*)

**The Effect of Size and Shape of the Specimen, Shape of the Notch and Grain Size of the Metal on the Fatigue Strength of Smooth and Notched Specimens in Medium Carbon Steel.** Ch. Massonnet, Liege University.

About 700 fatigue tests on medium plain carbon steel smooth and notched specimens submitted to alternate tension-compression, rotative bending, alternate bending, and torsion have revealed the following facts: (1) electrolytical polishing is the best means of preparation of the specimens for fundamental fatigue researches; (2) size effect is high in rotative bending, small in alternate bending, and nearly zero in alternate tension-compression; (3) stress-gradient at the root of the notch has an important effect on fatigue strength; (4) the notch sensitivity factor of fine-grained specimens obeys Peterson's law; (5) the effect of medium and coarse-grained structures obtained by two different heat treatments was to diminish the notch sensitivity factor and to stabilize it to a constant value of about 0.53 for a large variation of the stress gradient.

**Anisotropy of Fatigue Strength in Bending and in Torsion of a Steel and Two Aluminum Alloys.** W. N. Findley, Brown University, formerly with University of Illinois, and P. N. Mathur, University of Illinois.

An investigation of anisotropy in fatigue, under two different states of stress, bending and torsion, was made of two aluminum alloys and a steel.

The fatigue strength in bending decreased as the orientation changed from longitudinal to diagonal to transverse; and the fatigue strength in torsion was nearly constant at all three orientations.

The results of the tests are explainable from the concept that cyclic principal shear stress is primarily the cause of fatigue but the ability of the anisotropic materials to withstand this action of cyclic shear stress is influenced by the magnitude and the direction of the complementary normal stress acting on planes of principal shear stress, as well as anisotropic texture of the material.

**The Behavior of Long Helical Springs Under Fluctuating Load.** C. L. Staugaitis and H. C. Burnett, National Bureau of Standards.

A machine was constructed for testing long springs operating on a guide rod under fluctuating compressive load. Results of tests on the machine showed that wear on the guide rod reduced the life of the springs much below that of short springs tested at the same stress range. In springs tested at relatively high stress ranges, the initial fatigue crack apparently developed on planes of maximum shear stress parallel to the length of the wire. At relatively low stress ranges the initial crack usually appeared to be on a plane normal to the tensile stress. Lubrication of the specimens with dry molybdenum disulfide improved their fatigue life to some extent at relatively low stress ranges.

**The Effect of an Anodic (HAE) Coating on the Fatigue Strength of Magnesium Alloy Specimens.** J. A. Bennett, National Bureau of Standards.

The nonmetallic coating produced electrolytically on magnesium alloys by the HAE process provides greatly increased resistance to corrosion. In order to determine the effect of the coating on fatigue strength, bending fatigue tests of coated and uncoated specimens were made in machines of the constant amplitude of deflection type. The results showed that the coating caused a significant reduction in fatigue strength even when the stress on the coated specimens was calculated on the assumption that all of the load was supported by the underlying metal. The coating usually provided sufficient protection so that the fatigue strength was not reduced by salt spray exposure. There was no significant difference in the effect of the coating between smooth and notched specimens.

**Statistical Estimation of the Endurance Limit.** E. J. Gumbel, Columbia University.

The endurance limit is defined as the small stress at which the probability of permanent survival reaches unity. A new method is shown for estimating this probability from the number of broken and unbroken pieces. Then the probability of permanent survival is analyzed by the asymptotic theory of the smallest value of a limited variate, a method first used by Weibull on a purely empirical basis. The extrapolation of the probability to unity leads to an estimation of the endurance limit. Application to observations made by Cazaud, Bender, and Mehl leads to a satisfactory fit of the observed part of the survivorship function to this theory.

**Report of Committee E-9 on Fatigue.** R. E. Peterson, Chairman.

# New Tentatives and Numerous Revisions Approved by Standards Committee

In actions taken on February 3, March 2, and March 23, the Administrative Committee on Standards approved a number of new tentatives and revisions to existing tentative methods and specifications.

The standards affected are listed in the accompanying box with effective dates, and the changes recommended by the sponsoring committees are described briefly below.

### Steel

Committee A-1 recommended one new Specification for Untreated Carbon-Steel Axles for Export and for General Industrial Use (**A 383**), and revisions in a number of current tentatives. The new specification covers nonheat-treated axles for export, up to and including those $6\frac{1}{2}$ in. in nominal diameter at the center for passenger, freight, tender, and locomotive trucks; also nonheat-treated axles for domestic and export industrial trucks. It was developed because of the distinct difference that exists between forged carbon steel axles for domestic railroad use (which are covered in ASTM Specification A 21) and those exported.

Changes in Tentative Specifications for Welded and Seamless Steel Pipe (**A 53**) and for Electric-Resistance-Welded Steel Pipe (**A 135**) make transverse tension tests across the weld mandatory.

In order to bring Tentative Specifications for Seamless Carbon-Steel Pipe for High-Temperature Service (**A 106**) and for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service (**A 335**) in line with other tubular steel specifications, the committee recommended elimination of the dual tables of chemical requirements showing ladle and check analysis and substitution of a single table covering the range now shown as check analysis.

To Tentative Specifications for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service (**A 182**) has been added the following new grade steel with an F7 grade symbol designation:

| | |
|---|---|
| Carbon, max, per cent | 0.15 |
| Manganese, per cent | 0.30 to 0.60 |
| Phosphorus, max, per cent | 0.030 |
| Sulfur, max, per cent | 0.030 |
| Tensile strength, min, psi | 60,000 |
| Yield point, min, psi | 36,000 |
| Elongation in 2 in., min, per cent | 22 |
| Reduction of area, min, per cent | 50 |
| Silicon, per cent | 0.50 to 1.00 |
| Chromium, per cent | 6.0 to 8.0 |
| Molybdenum, per cent | 0.45 to 0.65 |

To improve marking clarity, grade symbol designations were changed from small to capital letters in Tentative Specifications for Alloy-Steel Bolting Materials for High-Temperature Service (**A 193**); and for Alloy-Steel Bolting Materials for Low-Temperature Service (**A 320**). These same changes were made in Standard Specifications for Carbon and Alloy-Steel Nuts for Bolts for High-Pressure and High-Temperature Service (**A 194**) at which time they were reverted to tentative status. There was the further change by the addition of a new grade 6 with the chemical composition of type 416 steel. The minimum tempering temperature is 1100 F and the hardness 248 to 352 Brinell. Minimum tempering temperature of grade 3 nuts is also changed from 850 F to 1050 F.

Tentative Specifications for Carbon-Steel Axles, Nonheat-Treated (**A 21**) were revised to coordinate them with the comparable AAR Specifications M 101.

In response to industry's need for an alloy-steel forging with a 100,000 psi yield strength, a new class 8 has been added to Tentative Specification **A 293** for Carbon and Alloy-Steel Forgings for Turbine Rotors and Shafts. This new class, with a tensile strength of 120,000 psi has the same chemical requirements as classes 5 and 6 except that carbon content shall be 0.45 per cent maximum.

Tentative Specification for Alloy-Steel Bars to End-Quench Hardenability (**A 304**) is brought up to date by deleting grades 2330 H, 2512 H, 4720 H, 8745 H, 9440 H, and 9445 H. Added are the following: TS4140 H, TS8620 H, 86B45 H, 84B17 H, and 9840 H. The hardenability Tables VII through XXXII are revised to reflect these additions and withdrawals.

To Tentative Specifications for Steel Machine Bolts and Nuts and Tap Bolts (**A 307**) the wedge test for testing the bolts was added.

Since the austenitic steels furnished under Tentative Specification for Low-Temperature Bolting (**A 320**) are the same as those furnished to Tentative Specifications for Alloy-Steel Bolting Materials for High-Temperature Service (**A 193**) it was decided to eliminate the grade designations of L8, L8c, L8t, and L8F in **A 320** and adopt those of **A 193**, that is, B8, B8c, B8t, and B8F.

The scope of Tentative Specifications for Quenched-and-Tempered Steel Bolts and Studs with Suitable Nuts and Plain Washers (**A 325**) is altered by the addition of the word "hardened" before the words "plain washers." It is felt that this clarifies the intent of the specification.

Because Tentative Specifications for Quenched-and-Tempered Alloy-Steel Bolts (**A 354**) were not too specific in requirements for test specimens, they have been revised to give detailed requirements for the types of test specimen to be used with the different sizes of bolts.

Twenty tubular steel specifications were revised to include reference to Tentative Methods and Definitions for the Mechanical Testing of Steel Products (**A 370**) in that section of each Specification which was formerly entitled "Test Specimens" and which is now entitled "Test Specimens and Methods of Testing." The revised text reads as follows: "The test specimens and the tests required by these specifications shall conform to those described in the Tentative Methods and Definitions for the Mechanical Testing of Steel Products."

Reference to **A 370** is deleted from the scope clauses of those specifications which are as follows:

- Welded and Seamless Steel Pipe (**A 53**)
- Seamless Steel Boiler Tubes (**A 83**)
- Electric-Resistance-Welded Steel Pipe (**A 135**)
- Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery Service (**A 161**)
- Electric-Resistance-Welded Steel and Open-Hearth Iron Boiler Tubes (**A 178**)
- Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes (**A 179**)
- Seamless Steel Boiler Tubes for High Pressure Service (**A 192**)
- Seamless Cold-Drawn Intermediate-Alloy-Steel Heat-Exchanger and Condenser Tubes (**A 199**)
- Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (**A 200**)
- Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (**A 209**)
- Medium-Carbon-Seamless Steel Boiler and Superheater Tubes (**A 210**)
- Seamless Alloy Steel Boiler, Superheater, and Heat Exchanger Tubes (**A 213**)
- Electric-Resistance-Welded Steel Heat-Exchanger and Condenser Tubes (**A 214**)
- Electric Resistance-Welded Steel Boiler and Superheater Tubes for High-Pressure Service (**A 226**)
- Welded Austenitic Stainless Steel Boiler, Superheater, Heat Exchanger and Condenser Tubes (**A 249**)

## Actions Taken by Administrative Committee on Standards, March 23, 1955

### New Tentatives

*Methods of:*

Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation (C 356 – 55 T)[a]

Continuous Analysis and Automatic Recording of the Sulfur Dioxide Content of the Atmosphere (D 1355 – 55 T)[a]

Test for Bulk Density of Granular Refractory Materials (C 357 – 55 T)

Determining Concentration of Odorous Vapors (D 1354 – 55 T)

*Specifications for:*

Tungsten Arc Welding Electrodes (B 297 – 55 T)[a]

Untreated Carbon Steel Axles for Export and for General Industrial Use (A 383 – 55 T)

Cold-Drawn Wrought Iron Heat-Exchanger and Condenser Tubes (A 382 – 55 T)

Zinc Coating (Hot Dip) on Assembled Steel Products (A 386 – 55 T)

*Definitions:*

Terms Relating to Atmospheric Sampling and Analysis (D 1356 – 55 T)[a]

*Recommended Practice:*

Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies (A 384 – 55 T)

and Design Suggestions for Providing High Quality Zinc Coatings (Hot Dip) on Assembled Products (A 385 – 55 T)

Planning the Sampling of the Atmosphere for Analysis (D 1357 – 55 T)

*Reference Radiographs:*

Steel Welds (E 99 – 55 T)

### Revisions of Tentatives

*Methods of:*

Sampling and Testing Untreated Paper Used for Electrical Insulation (D 202 – 53 T)[b]

Testing Sleeves and Tubing for Radio Tube Cathodes (B 128 – 52 T)

Test for Sublimation Characteristics of Metallic Materials by Electrical Resistance (B 278 – 52 T)

*Specifications for:*

Mild Steel Arc-Welding Electrodes (A 233 – 48 T)[a]

Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Electrodes (A 298 – 48 T)[a]

Carbon-Steel Axles for Cars and Tenders (A 21 – 47 T)

Welded and Seamless Steel Pipe (A 53 – 54 T)

Electric-Resistance-Welded Steel Pipe (A 135 – 54 T)

Seamless Carbon-Steel Pipe for High-Temperature Service (A 106 – 52 T)

Forged or Rolled Alloy-Steel Pipe, Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service (A 182 – 53 T)

Alloy-Steel Bolting Materials for High-Temperature Service (A 193 – 53a)

Alloy-Steel Bolting Materials for Low-Temperature Service (A 320 – 53 T)

Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts (A 293 – 52 T)

Alloy-Steel Bars to End-Quench Hardenability Requirements (A 304 – 52a T)

Steel Machine Bolts and Nuts and Tap Bolts (A 307 – 53 T)

Alloy-Steel Bolting Materials for Low-Temperature Service (A 320 – 53 T)

Quenched and Tempered Steel Bolts and Studs with Suitable Nuts and Plain Washers (A 325 – 53 T)

Seamless Ferritic Alloy Steel Pipe for High-Temperature Service (A 335 – 53 T)

Quenched and Tempered Alloy Steel Bolts and Studs with Suitable Nuts (A 354 – 53 T)

Welded and Seamless Steel Pipe (A 53 – 54 T)

Seamless Steel Boiler Tubes (A 83 – 54 T)

Electric-Resistance-Welded Steel Pipe (A 135 – 54 T)

Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery Service (A 161 – 54 T)

Electric-Resistance-Welded Steel and Open-Hearth Iron Boiler Tubes (A 178 – 54 T)

Seamless Cold-Drawn Low-Carbon Steel Heat Exchanger and Condenser Tubes (A 179 – 54 T)

Seamless Steel Boiler Tubes for High-Pressure Service (A 192 – 54 T)

Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes (A 199 – 54 T)

Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (A 200 – 54 T)

Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (A 209 – 54 T)

Medium-Carbon-Seamless Steel Boiler and Superheater Tubes (A 210 – 54 T)

Seamless Alloy-Steel Boiler, Superheater, and Heat Exchanger Tubes (A 213 – 54 T)

Electric-Resistance-Welded Steel Heat-Exchanger and Condenser Tubes (A 214 – 54 T)

Electric-Resistance-Welded Steel Boiler and Superheater Tubes for High-Pressure Service (A 226 – 54 T)

Welded Austenitic Stainless Steel Boiler, Superheater, Heat Exchanger and Condenser Tubes (A 249 – 54 T)

Electric-Resistance-Welded Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (A 250 – 54 T)

Welded and Seamless Open-Hearth Iron Pipe (A 253 – 54 T)

Copper Brazed Steel Tubing (A 254 – 54 T)

Seamless and Welded Ferritic Stainless Steel Tubing for General Service (A 268 – 54 T)

Seamless Austenitic Chromium-Nickel Steel Still Tubes for Refinery Service (A 271 – 54)

Seamless and Welded Austenitic Stainless Steel Pipe (A 312 – 54 T)

Seamless and Welded Steel Tubes for Low-Temperature Service (A 344 – 54 T)

### Revision of Standard and Reversion to Tentative

*Methods of:*

Test for Diameter by Weighing of Fine Wire Used in Electronic Devices and Lamps (B 205 – 49)

*Specifications for:*

Carbon and Alloy-Steel Nuts for Bolts for High Pressure and High Temperature Service (A 194 – 53)

*Recommended Practice:*

Cathode Melt Prove-In Testing (B 238 – 49 T)

[a] Approved March 7, 1955.

[b] Approved February 3, 1955.

Electric - Resistance - Welded Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (**A 250**)

Welded and Seamless Open-Hearth Iron Pipe (**A 253**)

Copper Brazed Steel Tubing (**A 254**)

Seamless and Welded Austenitic Stainless Steel Pipe (**A 312**)

Seamless and Welded Steel Tubes for Low-Temperature Service (**A 334**)

All of the specifications listed immediately above (with the exception of **A 83, A 134, A 179, A 192, A 214,** and **A 226**) were also revised with respect to yield point requirements.

### Wrought Iron

Committee A-2 proposed Tentative Specifications for Cold-Drawn Wrought Iron Heat-Exchanger and Condenser Tubes (**A 382**) to fill a need for suitable specifications for this type of material, arising from its increased use in industry. These specifications cover tubular products in sizes 1 to $3\frac{1}{2}$ in., inclusive, in outside diameter. This material shall be pig-puddled or processed wrought iron as defined in Standard Definitions of Terms Relating to Wrought Iron (A 81) and free of iron scrap or steel. Chemical composition requirements provide a maximum for manganese of 0.06 per cent; tensile strength and yield point are 40,000 and 24,000 psi minimum, respectively.

### Corrosion of Iron and Steel

Three new tentatives were accepted: Recommended Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies (**A 384**).

Recommended Practices and Design Suggestions for Providing High Quality Zinc Coatings (Hot Dip) on Assembled Products (**A 385**).

Tentative Specifications for Zinc Coating (Hot Dip) on Assembled Steel Products (**A 386**) covers steel products such as windows, fire reels, transformer vault frames and grates, dishwashing equipment, meat processing and handling equipment, laundry conveyors, screw conveyors and troughs, electric switching equipment, fire escapes etc. The zinc used for the coating shall be any grade of zinc conforming to Standard Specifications for Slab Zinc (Spelter) (**B 6**).

### Electrical Heating, Resistance and Related Alloys

Four methods and specifications have been revised by Committee B-4. Tentative Methods of Testing Sleeves and Tubing for Radio Tube Cathodes (**B 128**) now includes disk cathode measurement.

The Appendix to Tentative Recommended Practice for Cathode Melt Prove-In Testing (**B 238**) was revised. This includes "Instructions for Using Melt Testing Report Form" and the "Melt Testing Report Form."

In a move toward simplification and modernization, the committee has made a number of revisions throughout the Tentative Method of Test for Sublimation Characteristics of Metallic Materials by Electrical Resistance (**B 278**).

Standard Method of Test for Diameter by Weighing of Fine Wire Used in Electronic Devices and Lamps (**B 205**) was reverted to tentative status with revisions which specify the weighing equipment and the size of the balance in terms of the weight of the test specimen. In these revisions the conditions under which the average of multiple test specimens are used for determining wire size are more closely defined.

### Filler Metal

Three recommendations from the American Welding Society-ASTM Joint Committee on Filler Metal involve revisions of two tentatives and proposal of new Tentative Specifications for Tungsten Arc Welding Electrodes (**B 297**). These specifications cover nonfiller metal bare tungsten electrodes for inert-gas metal-arc (nonconsumable electrode method) welding and for atomic hydrogen welding. These electrodes, classified on the basis of chemical analysis, may be manufactured by any method that will yield a product conforming to the requirements of the specifications.

Thoroughgoing revision of Tentative Specifications for Mild Steel Arc-Welding Electrodes (**A 233**) including the Extensive Appendix material "Guide to AWS-ASTM Classification of Mild Steel Arc-Welding Electrodes" brings these specifications up to date and provides for the inclusion of new classifications for the iron powder type electrodes which have been in great demand by industry.

A similar revision was made in Tentative Specifications for Corrosion-Resisting Chromium and Chromium-Nickel Steel Welding Electrodes (**A 298**) bringing them up to date since their last edition in 1948. In addition eight new classifications are provided including the extra-low-carbon grades.

### Refractories

Tentative Method of Test for Bulk Density of Granular Refractory Materials (**C 357**) was proposed by Committee C-8 in order to establish a method of determining bulk density as opposed to existing ASTM methods which are applicable to full size refractory products or fairly large (25 cu in.) samples prepared from full size specimens. Commercial products of the material covered in these specifications usually have particles of 3 mesh or coarser.

### Thermal Insulating Materials

In Tentative Methods of Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation (**C 356**), Committee C-16 has dealt with insulations which are applicable to hot side temperatures in excess of 200 F (excepting insulating firebrick which is covered in ASTM Method C 210). In this test linear shrinkage refers to the change in linear dimensions of test specimens after they have been subjected to soaking heat for 24 hr and then cooled to room temperature. Most insulating materials will shrink at some temperature, and when a temperature is reached at which shrinkage becomes excessive, the material has definitely exceeded its useful temperature limit. Differential shrinkage which results between the hotter and cooler faces introduces strains and may cause warpage, which in turn can cause cracking. Shrinkage may also open gaps at the insulation joints rendering the application less efficient and more hazardous.

### Electrical Insulating Materials

Committee D-9 proposed deletion from Tentative Methods of Sampling and Testing Untreated Paper Used for Electrical Insulation (**D 202**) of the tests for water-soluble sulfates which are now considered superfluous in electrical insulating papers when the pH and water extract and water conductivity tests are made. For this reason deletion of the reference to the water-soluble sulfates method **D 1099** was recommended.

### Methods of Atmospheric Sampling and Analysis

The first efforts of this comparatively new committee which was established in 1951 were concentrated on definitions so that the methods and specifications growing out of their work would use the same accepted terminology. Tentative Definitions of Terms Relating to Atmospheric Sampling and Analysis (**D 1356**) is the result of this work. These Definitions will subsequently be augmented as the need for additional precision in terms becomes apparent.

Tentative Recommended Practice for Planning the Sampling of the Atmosphere for Analysis (**D 1357**) deals with general, statistical, meteorological, and topographical considerations involved in air sampling. Also included are 15 references.

Tentative Methods for the Continuous Analysis and Automatic Recording of the Sulfur Dioxide Content of the Atmosphere (**D 1355**) employ the method of absorbing sulfur dioxide in slightly acidified distilled water containing hydrogen peroxide and continuous recording of the electrical conductivity of the resulting sulfuric acid solution. The lower limit of the test is about 0.01 ppm; the upper limit can range from 3.0 to 10.0 ppm by simple modification of the liquid absorbent and gas volumes that are employed.

Tentative Method for Determining Concentration of Odorous Vapors (**D 1354**) reads as follows in its Scope clause:

"The activated carbon method described by this procedure is applicable to complex mixtures of vapors which constitute an air pollution problem because of their odor. The method is not recommended for determining individual vapors which, though odorous, are primarily significant for other reasons, such as toxicity or flammability, and for which chemical methods of analysis are readily available. Thus, the method would be used to measure the concentration of petroleum vapors outdoors in a refinery area, of odorants emitted in fat rendering operations, or of vapors incidental to human occupancy in a closed space, but not to measure the concentration of carbon tetrachloride over a solvent vat, or hydrogen sulfide in a chemical hood exhaust."

### Non-Destructive Testing

In response to a need expressed by industry, Committee E-7 has prepared Tentative Reference Radiographs for Steel Welds (**E 99**) illustrated and described on page 25.

# NEW ASTM PUBLICATIONS

## Symposium on Permeability of Soils

In principle, determination of the permeability of soils is quite simple. However, due to natural variations of material in place, it is often difficult to relate tests on small samples to larger masses. In sampling soils it is hard to prevent disturbing the moisture content or the structure of the soil. Changes in the air or chemical or organic content of the permeating fluid can cause large differences. Migration of particles may occur both in the field and laboratory. While some variables can be arbitrarily controlled or eliminated in the laboratory, it is often necessary to consider them in field applications. The papers in this symposium, which was held at the Annual Meeting in June, 1954, discuss the importance, evaluation, and control of most of these factors. Field permeability tests are compared, described, and evaluated by formulas. Correlations are presented between permeability and density and gradation of granular materials. A new sampler and a device for testing under small gradients are described. The importance of relating field tests to field conditions is stressed. The test value is expressed as length divided by time in a variety of units, but it is generally called coefficient of permeability, although hydraulic conductivity is suggested as being more consistent with other fields such as electrical and thermal conductivity. While the variety of field situations seems to preclude a single standard test method, it should be possible to increase the consistency of results by recommendation of preferred practices. Previous work is covered in a list of selected references.

Titles of papers and their authors are as follows:

Introduction—*Edward S. Barber, University of Maryland*

Principles of Permeability Testing of Soils—*D. M. Burmister, Columbia University*

Water Movement Through Porous Hydrophilic Systems Under Capillary, Electric and Thermal Potentials—*H. F. Winterkorn, Princeton University*

Low-Head Permeameter for Testing Granular Materials—*E. G. Yemington, Bureau of Public Roads*

Permeability Test for Sands—*T. Y. Chu, D. T. Davidson, and A. E. Wickstrom, Iowa State College*

The Permeability of Compacted Fine Grains of Soils—*T. W. Lambe, Massachusetts Institute of Technology*

The Permeability and Settlement of Laboratory Specimens of Sand and Sand-Gravel Mixtures—*C. W. Jones, Bureau of Reclamation*

Measurement of the Hydraulic Conductivity of Soil in Place—*D. Kirkham, Iowa State College*

Measurement of Permeabilities in Ground-Water Investigations—*W. O. Smith and R. W. Stallman, U. S. Geological Survey*

A Method of Determining the Permeability of Granular Materials, Using Air Subjected to a Decreasing Pressure Differential—*A. S. Weaver, University of Maine*

Selected References on Permeability—*A. I. Johnson, University of Nebraska.*

Copies of this 150-page symposium can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. Prices: $3; to members, $2.25.

• • •

## ASTM Proceedings Vol. 54

Once again the Society has published and distributed its annual *Proceedings*, fourteen hundred pages recording the technical accomplishments of the year. The volume includes reports and papers together with discussion offered to the Society during the year and accepted for the *Proceedings*. Leading the volume is the Summary of *Proceedings* of the 57th Annual Meeting, listing by title and author the program for each of 36 sessions. In the Annual Address by the president, L. C. Beard, Jr., in "Plain Talk" speaks out against the breakdown in communications among scientists, engineers, and management and urges a return to simple language which will make scientific matters clear to those with only a relatively elementary scientific background.

The Annual Report of the Board of Directors highlights matters administrative, technical, and financial, for the benefit of members. Included are records of all meetings held by the Society and its Districts; information on membership gains, publications, honors and awards, and other matters of interest.

Reports of the technical committees, of which there are 68, and their appendices provide a wealth of useful technical information as do the 37 technical papers and discussions on a wide variety of subjects pertaining to research and testing of materials.

In addition to the papers and reports embodied in the *Proceedings*, there are listed in the table of contents all Symposiums published separately as *Special Technical Publications (STP's)* and all papers published in the ASTM Bulletin.

Although the Society's publications program has expanded greatly in recent years, the *Proceedings* remain the repository of factual information and a record of the Society's work.

It should be emphasized that in addition to reports and technical papers, many of which have been given at the Annual Meeting and some of which have been preprinted, the *Proceedings* contain much discussion that has been submitted and not previously published.

• • •

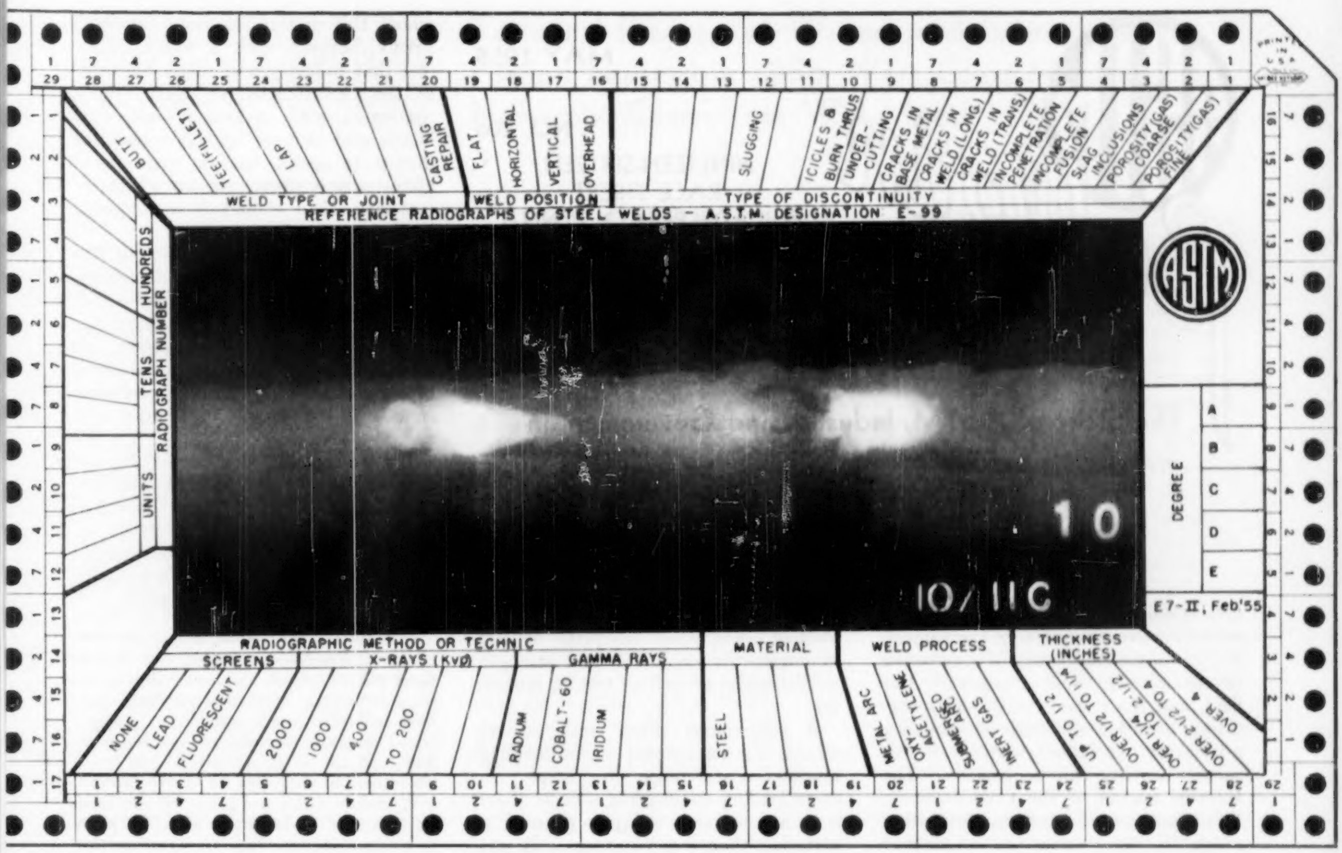
## Index to 1954 ASTM Standards

By the time this Bulletin reaches your desk ASTM members should have received their copy of the 1954 Index to ASTM Standards. Ten per cent larger than the 1953 Index, the new edition covers 1210 Standards and 854 Tentatives, or a total of 2064.

Subjects have been indexed under appropriate key words, and items under each subject are arranged alphabetically according to the significant word in the title. There is also a list of standards in continuous numeric sequence of ASTM serial designations. This list gives the complete title and the page number and part of the Book in which each standard may be found. When the ASTM designation of a particular standard is known, this list is especially useful.

Although prepared primarily for use in connection with the Book of Standards, the Index also contains information of general interest regarding the Society, its purpose and work, a list of ASTM administrative and technical committees, and information about other ASTM publications.

In addition to being sent to each member of the Society, the Index is distributed widely to industrial and Government organizations who purchase the Book of Standards and to libraries and others who find it a useful reference. The Index is one of the Society's most valuable annual publications.




## *Discontinuities in Steel Welds Interpreted by Long-Awaited ASTM Reference Radiographs*

After some four years of zealous effort by hard-working industry members of ASTM Committee E-7 on Non-Destructive Testing, reference radiographs covering types and degrees of discontinuities in steel welds have been approved for publication by the Society. The reference radiographs are reproduced from master radiographs taken of official sample weld plates which are the property of ASTM. There are 35 radiographs in the form of transparencies mounted in standard 5 by 8-in. Keysort cards as shown in the accompanying photograph. Details of plate thickness, radiographic method, and welding procedures are given on each card. The transparencies, although reproduced to a density level of approximately 1.0, retain the original radiographic contrast.

The reference radiographs are intended to serve as a guide for interpretation. No attempt has been made to establish limits of acceptability for any discontinuity. However, where applicable and upon agreement of all interested parties, they may be used in production inspection to evaluate weld soundness as provided for in product specifications.

For identification purposes, each type of discontinuity is designated by a number. The degree of severity for each defect is indicated by a letter.

Provision has been made for expansion of the card file as new reference radiographs become available.

The complete file of 35 radiographic transparencies in a cardboard container can be purchased for $50 from ASTM Headquarters, 1916 Race St., Philadelphia, Pa.

• • •

## *Symposium on Lateral Load Tests on Piles and Supplement*

This symposium and its supplement present in ten papers a wealth of information and data derived from tests of full-size piles and laboratory tests on model piles. Behavior of piles under different types of loading and in many kinds of soil conditions is described. The results of most of these tests have not been previously published. The symposium is sponsored by ASTM Committee D-18 on Soils for Engineering Purposes to make the actual test data available to the engineering profession. It is hoped the studies will lead to the development of standard procedures for making tests of this type.

The original symposium of eight papers was presented at the 56th Annual Meeting of ASTM in June, 1953. The two papers in the supplement were presented June 16, 1954, at the 57th Annual Meeting.

The information and data presented are of great value to the science of soils and foundation engineering and will be helpful to engineers concerned with the design of dams, water front structures, buildings, silos, and other structures resting on pile foundations.

Because the original symposium has had substantial distribution, copies of the supplement may be obtained separately at $1; 75 cents to members. Copies of the 104-page symposium and the 48-page supplement are available at a combination price of $2.75; $2 to members.

ASTM Bulletin

MAY 1955

NO. 206

NINETEEN-SIXTEEN RACE STREET PHILADELPHIA 3, PENNA.

# The Stake of ASTM, Industry, and Government in Engineering Education

### *Are Courses in Materials on the Way Out?*

THE imposing title of this article should not be taken as implying an exhaustive discussion of the subject. In view of the complexity of engineering education, the rapid changes in this field, and the responsibility and recognition accorded the engineer—and for a host of other reasons—articles on this subject usually can be lengthy. The Interim Report of the Committee on Evaluation of Engineering Education (June 15, 1954) under the auspices of the American Society for Engineering Education, itself covers some 26 pages—and we are much interested in this.

The preliminary study leading to this article dealt with the question whether our Society should continue to concentrate some of its promotional work (1) on the development of student memberships, (2) on junior memberships, or (3) on closer contacts by engineering schools and faculties with the Society—or all three. Since this matter has been debated for some years, the ASTM Directors called an all-day conference with representatives of engineering faculties, industry, and ASTM officers present. Attending were competent and responsible men who are vitally concerned with the work of the Society and with engineering education. The specific decisions, in a nutshell, were: (1) to put less stress and spend less money on direct student membership promotion; (2) to expend more time and effort on the "Junior" membership grade, but change this to an "Associate" class, raise the maximum age to 30 years, and simplify it in certain ways; and also (3) to stimulate more interest on the part of the engineering facility in ASTM work.

But one dismaying point about which some of us had worried a bit, and with which we are now intensely concerned was a major topic. This is an *apparent* shifting away from adequate courses in engineering materials and strength of materials, as well as testing laboratory.

A subsequent check with several schools not represented at the meeting revealed a difference of opinion. In some leading engineering schools there is no less emphasis today on training in materials than five years ago. It was feared—and there are many schools in which this trend *apparently* holds—that some courses must be dropped in order to give the engineers more science or humanities work, and that possibly the materials laboratory or certain other materials courses would have to be eliminated.

Not one of the many dozens of engineers and technical people with whom this matter has been discussed briefly, support such a trend. They feel that industry and many branches of the Government are more vitally concerned with materials than ever before and that we cannot expect industry to spend one or more years giving new engineers the knowledge of materials they should have acquired in their undergraduate days.

When we attend a meeting of the SAE or ASTM or other engineering or technical societies—what do we find occupying a most important part of the program? *Problems in materials.* In what category lodge many of the errors in judgment costing industry countless sums?—*Poor judgment in selection and use of materials.*

We are encouraged somewhat by the Interim Report of the ASEE Evaluation Group, noted above, which does not at least recommend less emphasis on materials courses. There is this quotation, under the heading "Unchanging Factors in Curriculum Design":

> But fortunately, some things do not change. Reactions, stresses and deflections will still occur, and they will have to be calculated. Electrical currents and fields will follow unchanging laws. Energy transformation, thermodynamics and heat flow will be as important to the next generation of engineers as to the present one. Solids, fluids and gases will continue to be handled, and their dynamics will have to be understood. The special properties of materials as dependent upon their internal structure will be even more important to engineers a generation hence. These studies encompass the solid unshifting foundation of engineering science, upon which the engineering curriculum can be built with assurance and conviction.

Again, under the heading "Opportunity for a Common Stem in Scientifically Oriented Curricula":

## Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

| DATE | GROUP | PLACE |
|---|---|---|
| May 11 | Committee E-1 on Methods of Testing | Philadelphia, Pa. (Society Headquarters) |
| May 17 | Committee E-11 on Quality Control | Philadelphia, Pa. |
| May 17–18 | Committee C-20 on Acoustical Materials | Philadelphia, Pa. |
| May 22–27 | Committee E-14 on Mass Spectrometry | San Francisco, Calif. (Mark Hopkins) |
| **June 26–July 1** | **ASTM Annual Meeting** | **Atlantic City, N. J. (Chalfonte-Haddon Hall)** |

The second major factor in the original definition of scientifically oriented engineering curricula included nine engineering sciences in sufficient strength to justify their separate listing; i.e., (1) statics, (2) dynamics, (3) strength of materials, (4) fluid flow, (5) heat flow, (6) thermodynamics, (7) electrical currents, fields and electronics, (8) engineering materials, (9) physical metallurgy. So that some quantitative measure may be available, it is tentatively suggested that each engineering science deserves from 2 to 6 semester hours, the average being about 4 semester hours. Hence, there would need to be a total of 36 semester hours for the engineering sciences mentioned, including appropriate substitutions of other applied sciences in special curricula.

Many companies and industries *reportedly* are demanding more engineering scientists and fewer engineers, but regardless of this, we cannot feel, even discounting the interests of ASTM, that engineers should be turned out with less knowledge of materials than they have been getting. As a technical society, distinct from a professional group, we have not thought it incumbent or appropriate to "attempt to influence" the engineering educational field. And yet, considering that ASTM, more than any society in the world, depends for its work on technically trained people, we should perhaps be doing more to achieve a proper perspective in engineering education. One appropriate way would be for *each* ASTM member (and, including our committee members, there are over 13,000 influential individuals) to keep in touch with his alma mater on this problem.

We'll have more to write on this subject. Meanwhile if you have any thoughts, write the Executive Secretary.

R. J. P.

## ISA Instrument Conference and Exhibit

"INSTRUMENTATION Paces Automation" is the theme of the Tenth Annual Instrument Conference and Exhibit of the Instrument Society of America which will be held at the Shrine Exposition Hall and Auditorium in Los Angeles, September 12–16.

Major features of the program will be a Maintenance Clinic headed by J. C. Groenewegen, Shell Chemical Corp., and an Analytical Clinic headed by Ed Goff, Beckman Instruments.

# Technical Program of Widespread Interest Will Feature September 1956 West Coast Meeting; Numerous Committees Will Meet

STRONG technical programs of widespread interest have always featured national meetings of the Society. This was true at the 1949 West Coast meeting, the first held in that area, and is also true of the program for the Second National Meeting in Los Angeles, September 16 to 22, 1956, which will have a number of outstanding sessions and symposiums.

Meeting in Los Angeles in February with the technical program committee and the general committee officers, ASTM President N. L. Mochel and Executive Secretary R. J. Painter reviewed the projects to be sponsored by various technical committees as well as numerous suggestions made by members on the West Coast and others. The major subjects either being developed or to be considered carefully for a place on the program are:

*Symposiums on:*
- Electrodeposited Coatings
- Radioactive Isotopes
- Railroad Materials
- Industrial Water

*Sessions on:*
- Fatigue of Aircraft Structural Materials
- Non-destructive Testing
- Paint
- Significance of Specifications and Tests
- Plastics
- Titanium
- Concrete

*Papers on:*
- Electronics
- Reinforced Masonry
- Asphalts for Use in Paving Work
- Abraiding Properties of Aggregates for Road Beds
- Soils for Engineering
- Statistical Methods
- Colorimetry
- Photometry

While some of these items are definite others are in the planning stage and the list should be considered a tentative one subject to change within the next few months. The purpose here is to give our members some concept of the wide range of subjects that will be covered.

The General Committee on Arrangements through its Technical Program Committee and in cooperation with the Administrative Committee on Papers and Publications will insure an attractive program that should have at least several subjects of appeal to any of our members who may attend.

The Program Committee was pleased with the fine cooperation and interest shown by many of the technical committees (and it is known that others are considering special sessions) and also with the interest of the West Coast members who, following requests from the Program Committee, had submitted a long list of topics considered pertinent.

### Notes on Technical Committees, Exhibit, and Other Features

At the two all-day planning meetings on their western trip the President and Executive Secretary reviewed not only technical program developments but other areas of concern involving the 1956 meeting. The officers are very appreciative of the considerable time expended by the local ASTM members.

It was announced that the Board of Directors would hold their 1956 September meeting on the West Coast; also that there would be sponsored a West Coast Exhibit of Scientific Instruments and Testing Equipment even though the main 1956 Exhibit will be held in June at Atlantic City. The exhibit in Los Angeles will provide an opportunity for the growing number of instrument and laboratory supply manufacturers and distributors there to show to a select audience some of their newer developments.

**Technical Committees:** A number of ASTM technical committees have indicated their intention to hold meetings during this week. This list includes the following:

| | |
|---|---|
| B-8 | Electrodeposited Metallic Coatings |
| C-1 | Cement |
| C-7 | Lime |
| C-9 | Concrete and Concrete Aggregates |
| C-19 | Structural Sandwich Constructions |
| D-1 | Paint, Varnish, Lacquer, and Related Products |
| D-2 | Petroleum Products and Lubricants |
| D-4 | Road and Paving Materials |
| D-7 | Wood |
| D-8 | Bituminous Waterproofing and Roofing Materials |
| D-18 | Soils for Engineering Purposes |
| D-19 | Industrial Water |

It is expected others will also meet. The presence of technical committees will assure a good attendance. In addition, it is expected other nonsociety groups in which there are numerous ASTM members will be meeting

before or after the ASTM week. One such group is the Technical Committee of the Portland Cement Association, which is meeting the previous week in Seattle.

All meetings and the exhibit will be held at the Hotel Statler where ample facilities have been reserved. The Statler is completing a new moderate-size exhibit hall which will be adjacent to the technical meetings and registration, with a convenient loading entrance right off Wilshire Boulevard.

Features of the successful 1949 meeting that will be continued are the industry luncheons. These were sponsored by the petroleum, cement, timber, and other groups, bringing together interested individuals at a short luncheon program. A special local committee will assist with these.

The accompanying photographs show a number of the men who participate actively in the District work and who have responsibilities for the 1956 meeting.

A national meeting of the Society comprises a good technical program, numerous meetings of technical committees, and usually a number of business and entertainment features. Each of these areas will be developed fully by the committee in charge for the 1956 meeting. *Plan to attend.*

## Nominations for Society Offices

THE Nominating Committee met at Headquarters in Philadelphia on March 18 to select nominees for the Society offices of President, Vice-President, and Directors.

In accordance with the By-laws of the Society, the Nominating Committee has announced the following nominations:

*For President* (term 1 year)

**C. H. Fellows,** Director, Engineering Laboratory and Research Department, The Detroit Edison Co., Detroit, Mich.

*For Vice-President* (term 2 years)

**R. T. Kropf,** Vice-President and Director of Research, Belding Heminway Co., Inc., New York, N. Y.

*For Directors* (term 3 years)

**R. C. Alden,** Chairman, Research Planning Board, Phillips Petroleum Co., Bartlesville, Okla.

**A. A. Bates,** Vice-President of Research and Development, Portland Cement Assn., Chicago, Ill.

**F. L. LaQue,** Vice-President and Manager, Development and Research Division, The International Nickel Co., Inc., New York, N. Y.

**E. F. Lundeen,** Metallurgist, Sheet and Strip Division, Metallurgical and Inspection Department, Inland Steel Co., Chicago, Ill.

**J. C. Moore,** Director, Technical Section, National Paint, Varnish and Lacquer Assn., Inc., Washington, D. C.

*Daily News Record*

**The awarding of the H. DeWitt Smith Medal by Committee D-13. Left to right: W. J. Hamburger (for other news of Dr. Hamburger, please turn to pages 5 and 6); Medal recipient, J. H. Dillon; W. D. Appel, Chairman of the Textile Committee; and A. G. Ashcroft.**

**To ASTM Members: Your help is needed in maintaining that constant increase in ASTM Membership**

**To the ASTM Committee on Membership,**
**1916 Race St., Philadelphia 3, Pa.**

**Gentlemen:**

**Please send information on membership to the company or individual indicated below:**

______________________________

______________________________

**This company or individual is interested in the following subjects: indicate field of activity, that is, petroleum, steels, non-ferrous, etc.**

______________________________

Signed______________________

**Date**______________________ Address______________________

## Dillon Honored for Textile Science Contributions

Gathering to do honor to one in their midst who had distinguished himself by his contributions to textile science and technology, members of the ASTM Textile Commmittee and friends witnessed the presentation of the Harold DeWitt Smith[1] Memorial Award to John H. Dillon, Director of the Textile Research Inst., Princeton, N. J. The award was presented at a luncheon in honor of the medalist in the Statler Hotel in New York on March 17, 1955. The Medal and Award are contributed by Fabric Research Laboratories, Inc., Dr. Walter Hamburger, Director.

In introducing the Medalist, A. Griffin Ashcroft commented on the character of the Harold DeWitt Smith Memorial Award: "The purpose...is to stimulate the scientific approach to the use of textile fibers and the award is given for outstanding achievement toward that purpose. There are four elements listed...[as] criteria: The first is scientific achievements in the development of fundamental knowledge in textile fibers and their evaluation—second is contributions toward the acceptance and use of this knowledge by industry—third is contributions to textile education—and the fourth is contributions to the organization of group research in the textile field. Jack Dillon fulfills each of these criteria."

Mr. Ashcroft outlined Dr. Dillon's important contributions to basic research—in exploring the basic laws of nature in chemistry, physics, and mathematics—so as to provide a sound basis on which to build the advance in textile technology. His outstanding contributions to education have been the development of fellowship programs for the training of research scientists and the building up of a center for research and education in textiles.

[1] The nineteenth ASTM Edgar Marburg Lecture "Textile Fibers—An Engineering Approach to Their Properties and Utilization" was presented by Harold DeWitt Smith at the Annual Meeting in June 1944, of the ASTM.

#### Medalist Stresses Industry-Wide Problems

In his response, Dr. Dillon modestly attributed most of the credit for his success to the work of others—his colleagues of the Institute Staff for the scientific contributions, his advisers of various committees, and guidance from the Institute's Trustees.

Tracing the notable events in textiles which have followed the famous Marburg Lecture of Harold DeWitt Smith before the ASTM in 1944, Dr. Dillon mentioned the many new synthetic fibers which have been developed. These include 6-6 nylon, the first of the hydrophobic apparel fibers, which was coming into its own around 1944; then the polyacrylic, polyvinyl acrylic, and later the polyester fibers were developed. Though these new hydrophobic fibers introduced new and useful properties of wet wrinkle resistance and stability in laundering, they also introduced new problems including pilling, static electrification, low softening point, and difficulty in dyeing. He pointed out that ". . .because these fibers were produced by scientists, these problems were recognized and are now being eliminated, one by one. Unfortunately, many firms in the textile industry paid very little attention to the engineering principles developed so clearly in Dr. Smith's Marburg Lecture, and many of the new fibers were used carelessly without any real understanding of their advantages and limitations. In spite of this, the new fibers have prospered. . . ."

Continuing, Dr. Dillon said that it must have been discouraging to the scientists who developed these new fibers to find how little the textile industry really knew about its old raw materials and what happened to them in processing. Because of this and the limited concept of consumer needs and desires, many unsuitable fabrics were produced and progress with the new fibers was not what it might have been.

One of the basic industry-wide problems which gets little attention is related to the matter of fiber length. The length distribution of raw sheared wool, or cotton taken directly from the seed is found to be almost completely uniform. On processing, however, these fibers are damaged and broken and the length distribution becomes far from uniform. It is the short fibers that cause trouble in processing and make poor yarns.

Emphasizing the importance of the test method, Dr. Dillion pointed out that the conventional method of measuring average length based on weight-averaged length distribution are very insensitive in revealing the presence of the short fibers which are the real offenders. The industry ruins its raw materials and then tries to patch them up by processing tricks and finishing treatments. He commended the ASTM Textile Committee for its program to develop practical methods for measuring number-length distribution which will provide a tool for attacking this basic problem.

In closing, Dr. Dillon thanked sincerely all his good friends of Committee D-13 for the honor bestowed upon him, stating that possession of the Harold DeWitt Smith Memorial Award will stimulate and encourage him to be worthy of this honor in his future work.

# District Activities

## President's 1955 West Coast Trip Includes Many Meetings, Industrial Visits

In their four-week trip across the country, February 6 to March 6, President Norman L. Mochel and Executive Secretary R. J. Painter spoke at nine technical meetings, met in many informal sessions with groups of members and others concerned with our work, and made numerous industrial or related visits. Both men felt very gratified with the meetings and contacts made.

One of the important objectives of the trip was a series of committee meetings with the General Committee on Arrangements for the 1956 West Coast Meeting (September 16–22) in Los Angeles. Results of this planning are described on page 27. With the fine cooperation and interest of our Southern California members, much was accomplished.

Each of the technical meetings was held jointly with some local sections of other societies, several with chapters of the American Society for Metals, whose members were particularly interested in the subject of the President's talk "Power and Materials—Now and in the Future" which dealt largely with metals. This talk will be published later in the BULLETIN.

At each meeting the Executive Secretary gave a short coffee talk on some aspects of "Cooperation in Materials' Research and Standards," stressing necessity of using the time of our engineers and technical men to the best advantage with a minimum of duplication of effort. He also expressed the Society's appreciation to other national societies and trade groups for their support of ASTM work in standards and research.

The accompanying article is largely for the information of any of our members and officers interested. In the informal notes are interspersed occasionally some personal comments or reactions on the part of the President or Executive Secretary.

**At the Bartlesville meeting, standing left to right: H. M. Cooley, Bethlehem Steel Co.; R. E. Forney, local ASME Chairman; E. K. Riddick, Engineers Club, Bartlesville. Seated: ASTM Executive Secretary R. J. Painter; ASTM President N. L. Mochel; and R. C. Alden, Vice Chairman, ASTM Southwest District Council.**

### BARTLESVILLE (February 8)

This meeting was sparkplugged by R. C. Alden, Phillips Petroleum Co., a very active member and officer who is Vice-Chairman of the Southwest District and of the Petroleum Committee. He had fine assistance from Herbert M. Cooley, Bethlehem Steel Co., Tulsa; Paul Ogden of Phillips, and others. The Bartlesville Engineers' Club (Edgar Riddick, Executive Vice-President) were hosts and were joined by the Tulsa Chapter of ASM (George Sykora, Chairman), and Mid-Continent Section of ASME (Bill Forney, National Tank Co., Chairman). Despite a local championship high school basketball game which drew over 2000, there were over 150 at the Central High Auditorium for the technical meeting which was the first ASTM District Meeting in Oklahoma. Several members came from a considerable distance. (The officers noted that at virtually every meeting in the West there were some loyal ASTM members and others who drove 100, 150 miles and even further to be present. Many were thanked personally, and this note extends appreciation to all.)

Many, but not all, Bartlesville workers are part of the Phillips organization which has its headquarters and main research activities centered here. The facilities in the new Phillips Office Building are noteworthy. Marking the skyline is a tall new office and apartment structure by Frank Lloyd Wright, striking with its cantilevered construction. No one in this area should miss the famed Woolaroc Museum and Ranch. Here is a world-famous collection of western and Indian items, marvelous paintings, Indian products including an extensive collection of Navajo rugs, and many other exhibits. For those who like the West, several hours here are profitable.

Local interest item—Alden "selling" Mochel a share in Oklahoma's first commercial oil well. Recorded on film!

### KANSAS CITY (February 9)

A local ASTM committee had invited all members in the area to a dinner meeting with the visiting officers. Including representatives from other societies, upwards of 40 were present at the Kansas City Club. This was the first ASTM meeting of any kind in Kansas City. Short discussions about the Society touched on the question of keeping alert to industry's technical needs, ASTM publications, engineering education, etc. It was agreed that engineering students should continue to be given good courses in materials. Some felt there should be a more coordinated effort to insure this.

Discussion of technical committee operations noted that much of the Society's strength comes from the considerable autonomy each technical group enjoys. As these groups grow, problems such as secretarial servicing are entailed, but the industries concerned have cooperated splendidly. The place of technically trained women was noted.

A number of informal meetings as this one have been held in recent years whenever a national officer visits various industrial centers. Because of the great diversity of our work it has not been thought feasible to organize districts or local activities unless there is a good concentration of members. But some thought may be given to having occasional get-togethers of our members under local auspices.

N. T. Veatch, Jr., Black & Veatch, handled preliminary arrangements with other committee members, A. J. Griner, Owner, A. J. Griner Co.; Harry F. Bennetts, Executive Secretary, National Lubricating Grease Inst.; and F. A. McCoy, Chief Metallurgist, Sheffield Steel.

Members and guests meeting with the president in Kansas City. Seated at the head table: H. M. Steineger; President Mochel; Claude Johnson; Executive Secretary. Standing extreme left: Harry F. Bennetts; Professor C. H. Scholer is behind Mr. Johnson and A. J. Griner at his left. H. B. McCoy is seated third from the right.

Among those present was C. H. Scholer, Professor of Applied Mechanics, Kansas State College, longtime ASTM committee worker and then President, American Concrete Inst. Local chapter officers of ASCE, ASME, AIEE, ASM, ACS, and AIChE were guests. H. M. Steineger, Superintendent, Sugar Creek Laboratory, Standard Oil Co. of Indiana, presided at the meeting. Claude Johnson, head of Jesco Lubricants Co., longtime ASTM member, was at the head table.

Of intense local interest was the former Philadelphia A's Ball Club, now in Kansas City. Strange for the two Philadelphia officers after so many years!

### DENVER (February 10)

This joint meeting, again a first for ASTM in mile-high Denver, was a good one, held at the Oxford Hotel, where our hosts, the Rocky Mountain Chapter of ASM has held its meetings for many years. Ray McBrian, Denver & Rio Grande Western Railroad Co., a longtime ASTM worker, who did much to establish the ASM Chapter, was unfortunately away, but Chairman Mark Davidson, Thompson Pipe & Steel Co.; Fred Blair, Blair Engineering Co.; and Clyde Penney, Denver & Rio Grande Western Railroad Co., ASM secretary, were fine hosts. About 75 present, including representatives of the U. S. Bureau of Reclamation and Gates Rubber Co. Walter H. Price, Head, Engineering Laboratories, Bureau of Reclamation, was technical chairman. He is currently Chairman of ASTM Committee C-9 on Concrete.

The chief visit was to the extensive Engineering Laboratories, U. S. Bureau of Reclamation in Denver's Federal Center, west of the city, where the ASTM officers met L. N. McClellan, Bureau Assistant Commissioner and Chief Engineer. Many active ASTM members carry on their important work here, among them, in addition to Walter Price, R. C. Mielenz (twice ASTM Thompson Award Winner); W. G. Holtz, secretary of ASTM Committee D-18, and his associate, A. A. Wagner, assistant secretary; and G. E. Burnett, Committee D-1 member. The Bureau has a tremendously wide range of interest in hydraulics problems and materials of all kinds. It is vitally concerned with Colorado's most pressing problems—water supply and power. Diversion of water into southeastern Colorado is a live topic.

At the Bureau of Reclamation, Denver Federal Center. Left to right: L. N. McClellan, President Mochel, W. H. Price.

Denver is agog with the new U. S. Air Force Academy to be located south of the city toward Colorado Springs.

### SALT LAKE CITY (February 12)

This was a day's stopping point on the way to the Northwest. The huge Bingham Copper Mine is awe-inspiring. The large smelters are near Salt Lake. The thousands of wood poles used to carry the power lines reminded us of the ASTM Wood Pole Research Project now under way in the Forest Products Laboratory. The tests and specifications standardized by Committee B-5 on Copper and Copper Alloys and other ASTM groups, have done much to assure widespread use of these products.

### RICHLAND, WASH. (February 14)

At annual joint meetings of various societies in this area, President Mochel had been preceded by Past-Presidents Fuller, Maxwell, and Beard. Cooperating were the local chapters of ASM, ASME, AIChE, and ACS. The accompanying photograph shows several officers of these groups. About 80 were present in the Chief Joseph Junior High School Cafeteria, including a good contingent from Walla Walla College. Lewis Reed served as program chairman and handled advance details too.

**Richland, Wash. Standing, left to right: L. S. Reed, ASM; W. M. Harty, AIChE; S. Bell, AIChE; R. J. Painter; Evan Baker, ASM; G. S. Cochran, ASME; E. L. Reed, ASME; J. R. Carrell, ASME. Seated, left to right: M. J. Sanderson, ASM; C. F. Fahl, AIChE; G. Alkire, ASTM; President Mochel; L. D. Turner, ASM; and M. G. Patrick, ASME.**

George Alkire, active ASTM committee member, presided at the meeting, which was opened by L. D. Turner, ASM chairman.

---

It is always interesting to visit a virtual one-industry town which is what the Hanford Works makes Richland—one of the fabulous construction projects of the last decade. Colossal McNary Dam on the Columbia, about 30 miles away, backs up the Columbia for many miles. The huge concrete structure cost about $290,000,000 and will develop a great volume of power. While the Columbia is a big river, it ranks well down the world list from the standpoint of volume discharge, but its series of flood control and power dams make it strategic in the Northwest.

## TACOMA (February 15)

This was a joint meeting with Tacoma Engineers' Club. Harold Hagestad, Club President, represented the host, and Arthur R. Anderson, Concrete Engineering Co., active ASTM member, was technical chairman.

---

Leaving a conference with Boeing engineers at their big bomber plant No. 2, the ASTM men were caught in the closing rush hour of the thousands of employees needed to turn out the big bombers, including the giant new B52. There is much interest in prestressed concrete work in this area with Concrete Engineering Co. carrying out some interesting research. Other materials are used prestressed too, even some experimental timber structures are using prestressed members.

The use of standards in the aircraft industry is tied very closely to military requirements. But as the aircraft manufacturers develop industry products, for example, small gas turbines, the use of industry standards will increase.

## SEATTLE (February 16)

An excellent joint meeting with the Puget Sound Chapter, ASM, attended by 80 to 90 men at the Seattle Engineers Club. Jack Sweet, Chief Metallurgist, Boeing, and Tom Williams, Head of the Northwest Industrial Laboratories, represented ASTM; Bill Slosson, Metallurgist at Boeing's No. 1 Plant, and ASM Vice-Chairman, headed the Program Committee; Clint Lundy, ASM Chairman, Kaiser Aluminum and Chemical Corp., and Dave Meslang, ASM Secretary, Crucible Steel Co., aided in making this meeting a very cordial one.

---

President Mochel who is vitally concerned with big ship power plants was invited to inspect the Battleships Indiana and Alabama at the Bremerton Navy Yard where Lieutenant-Commander John W. Ross, Jr., was our gracious host. It was a thrill also at the invitation of Captain North to stand on the Battleship Missouri's deck where MacArthur received the Japanese surrender. A few days later the Missouri was decommissioned.

## PORTLAND (February 17)

The meeting in Portland was an informal gathering of ASTM members at a short luncheon. W. B. Kirby, Chief Engineer, Electric Steel Foundry Co., and T. K. May, West Coast Lumbermen's Assn., were the local committee. An active participant in the discussion was S. H. Graf, for many years Head of Mechanical Engineering at Oregon State College and now Professor Emeritus and a member of ASTM since 1911. Again the members stressed the importance of the engineering student receiving a basic understanding of materials, their properties and tests.

## SAN FRANCISCO (February 23)

This active group maintained its unbroken record of meeting the visitors no matter what hour they arrive and at midnight T. P. Dresser, Jr., Abbot A. Hanks, Inc., former Director, and P. V. Garin of the Southern Pacific Co., currently a Director, met our party. The joint meeting with the Golden Gate Chapter of ASM was held in Oakland at the Villa de la Paix. The local ASTM District officers—Harry Hoopes, Pabco Products, Chairman; Paul McCoy, American Bitumuls and Asphalt Co., Vice-Chairman; and Bob Harrington, Clay Brick and Tile Association, Secretary—had cooperated closely with the ASM Golden Gate officers, Messrs. Archer, Walberg, Kraybenbuhl, and Drake. There was a good attendance and much interest, about 150 being present at this meeting.

### District Council

The Northern California District Council meeting at 4 p.m. was well attended. The membership report showed much activity. The committee, headed by G. J. Grieve who cooperates closely with Headquarters Staff, has many contacts. The local District supports the Science Fair financially and has a keen interest in the 1956 West Coast Meeting. It will participate in all phases of the work through direct representation. Parker Dresser

**Seattle. Standing, left to right: T. H. Williams; W. L. Slosson, local Vice Chairman, ASM; R. J. Painter; D. R. Meslang, local Secretary-Treasurer, ASM; seated: C. R. Lundy, local Chairman, ASM; President Mochel; and J. W. Sweet.**

**Southern California District meeting, left to right: B. P. Weintz, District Secretary; Jack Dickason; Elmer Bergman; President Mochel; S. R. Kallenbaugh; and Myron Niesley, District Vice Chairman.**

**Southern California meeting, left to right; C. M. Wakeman; R. E. Paine; Bill Eisenman, Secretary, ASM; and R. J. Painter.**

is Vice-Chairman of the General Committee.

---

San Francisco continues one of America's most interesting areas. Monday, February 21, two plants were visited—the Sunnyvale plant of Westinghouse and the Military Personnel Carrier Plant of the Food Machinery Co. at San Jose. The production of medium and larger size turbines at Sunnyvale essentially provides a new industry in that area, but of primary interest to the visitors was the huge compressor for the world's largest wind tunnel (to be set up in Tennessee) which has disk forgings over 18 ft in diameter; huge bucket blades, some of them 5 to 6 ft long; a tribute to the metallurgists and, of course, the production engineers.

The large heavy forgings brought to mind the expediting work ASTM did during war time in establishing emergency specifications for heavy forgings such as ship shafting, turbine rotors, etc. These standards are now widely used.

We noted several suppliers of materials who should be in ASTM. While our members are alert to membership prospects, there are still many cases where companies could benefit from membership and help advance the work.

At San Jose one was impressed with the importance of materials technology again—particularly in this instance fabrication problems with the tremendous amount of welding.

Several social functions included a dinner party of District officers and their wives.

## LOS ANGELES (February 24)

Former District Chairman, J. B. Morey, International Nickel Co., had completed many of the joint meeting arrangements before he was transferred to a more responsible position in Cincinnati. The meeting at Rodger Young Auditorium was the best attended of the trip with 250 present for dinner and the technical session. S. R. Kallenbaugh, Timken Roller Bearing Co., presided as ASM chairman, and Myron B. Niesley as ASTM chairman, introduced the ASTM people including Past-President Barr, Former Directors W. C. Hanna and Ord Slater and the Executive Secretary who spoke briefly, as did Bill Eisenman, National ASM Secretary. Roy Paine of Alcoa, Myron Niesley, and others are active in both groups. The Saugus Iron Works restoration recently described in the ASTM Bulletin was shown in a color film. Harry Maradudin, Materials Engineer, Standard Oil of California, introduced President Mochel.

---

Many technical meetings are held at Rodger Young Auditorium which has been refurbished and is a fine meeting place.

**Northern California District Council at the Oakland Meeting. Front row, left to right: T. P. Dresser, Jr.; Executive Secretary; P. F. McCoy, District Vice-Chairman; H. P. Hoopes, District Chairman; President Mochel; P. V. Garin; W. C. Riddell; G. H. Raitt. Standing: H. de Bussieres; L. A. O'Leary; R. G. Wadsworth; C. H. Fitzwilson; H. A. Williams; W. N. Lindblad; Ralph Vollmar; M. C. Poulsen; R. W. Harrington, District Secretary; J. H. Dunn; Dozier Finley, Honorary Member.**

The ASM, Los Angeles Chapter, owns excellent meeting equipment—projectors. amplifiers, etc.—all of which are much appreciated by the speakers. Small screens and poor projectors detract all too frequently from technical talks.

The Los Angeles freeways are fabulous, showing what can be done to expedite extremely heavy traffic. ASTM standards for cement, concrete, reinforced steel, etc., play a major part in better highways.

## HOUSTON (March 1)

The ASTM Southwest District Council continues its active program in this meeting with the Texas Chapter of the ASM at the Ben Milam Hotel. Arthur Oakley, Jr., ASM chairman, introduced various guests and Milton E. Holmberg, ASTM chairman, introduced the speakers. The spirit of this meeting might be considered a reflection of the general attitude in the Southwest, namely, dynamic, good natured, and yet well conducted—about 140 present, including a number of ASTM men. Among those present were A. B. Campbell, Executive Secretary, National Association of Corrosion Engineers, who is a member of the ASTM Council.

In Houston and throughout the trip there were several Westinghouse representatives present. An ASTM President gets a warm feeling from his company's support as we know from the reactions of Past-Presidents H. L. Maxwell and L. C. Beard, Jr., Du Pont and Socony-Vacuum, respectively.

Visits included the University of Houston where we talked about courses in materials with the new president, General A. D. Bruce, who is anxious to build up further their engineering department; the Cook Heat Treating Co. plant was inspected, where Charles F. Lewis, one of the primer movers of the ASTM District, is metallurgist and Clifford Cook is national President of the Metal Treating Inst.

The open-air station of the Houston Power and Light Co. presents an unusual picture with the turbines and generators, and boilers out in the open—a trend many companies are following even in northern areas. Here as in all sections of the country there is an insatiable demand for more and more power. And consequently larger equipment, condensers, turbines, and boilers are being built—all making extensive use of ASTM standards—forgings, piping, structural steel, etc.

A notable development in this area is the Cameron Iron Works' 11,000-ton forging press which can apply horizontal as well as vertical pressure, enabling certain rocket equipment, valve bodies, etc., to be forged nearly into final shape thereby reducing machining. Parts up to 4000 lb are being handled regularly.

The Dallas meeting. Left to right: Jack Turbitt, local Chairman, ASM; President Mochel; J. P. Fowler, local Secretary, ASM; and Edwin Joyce, Vice Chairman, Southwest District.

## DALLAS (March 3)

The North Texas Chapter of the ASM, our Fort Worth-Dallas hosts, met at the Amon Carter Air Field. Edwin Joyce, API Division of Production, and Vice-Chairman of ASTM's Southwest District, cooperated to arrange this meeting. ASM Chairman Jack Turbitt presided and Secretary J. P. Fowler of Texas Steel Co. introduced President Mochel to the 60 in attendance.

It was good to see Ed Joyce, an old friend who was Assistant Director, National Emergency Steel Project in the War Production Board days. With Bill Strang, Secretary, API Division of Production, there is maintained a very active and effective standardization project on oil country goods and related materials. Don Hart, Rainhart Co., instrument manufacturers, and Fred Riggan, for many years with the Key Co., now with Texas Steel Co., were other longtime ASTM members who greeted us. The new Republic Bank is fabulous with its 14-carat gold decorated balcony, imported Scottish rugs, and elaborate officers' quarters.

At Houston; Second from left, Mack Crook; fourth from left, President Mochel; sixth from left, C. F. Lewis and next to him, M. E. Holmberg. Southwest District Chairman; third from right, Don Wilson; and at far right, Arthur Oakley, Jr., local ASM chairman.

Joint Meeting of ASTM Southern California District Council and Arrangements Committee for 1956 West Coast Meeting. 1st row, seated, left to right: W. C. Hanna; Harry Welch; William Barr; and Fred Doolittle. 2nd row, seated: Claude Emmons; Carrol Wakeman; Byron Weintz; President Mochel; Myron Niesley; Ord Slater; R. J. Painter; and John Herbert. 3rd row, standing: James Rich; Bruce Wiker; Curtis Beardsley; C. E. P. Jeffreys; Raymond Stringfield; Elmer Bergman; Bert Folda; Don Bowers; David Wilson; Ernest Maag; John Howe; and G. R. Little.

## Southern California District and National Actions

These notes will take cognizance of actions at the combined meeting of the Southern California District Council and the General Committee on Arrangements for the 1956 West Coast Meeting held during the visit of Messrs. Mochel and Painter to Los Angeles on February 25.

#### District Matters

The Council designated M. B. Niesley, President, California Testing Labs., as District Chairman succeeding J. B. Morey, and appointed Byron Weintz, Chief Engineer, Consolidated Rock Products Co., now Secretary to be Vice Chairman-Secretary. Later the Council expects to appoint an assistant secretary but these two men will direct the District work through June, 1956. They are taking an active part, too, in the 1956 national West Coast Meeting.

The Council plans to sponsor student membership prize awards at leading engineering schools in the area. Students with outstanding records in courses involving materials and related subjects will be given a free student membership in the Society, the cost being handled through the local council. Several other Districts have adopted this policy as a very worthwhile local activity—the school, the student, and ASTM benefitting.

The Council is anxious to stimulate more ASTM memberships in Los Angeles which is still growing by leaps and bounds. There are many companies there whose personnel would benefit from contacts with the Society.

The Council meetings in recent years have been marked by one interesting situation, the presence always of numerous past chairmen. This time every chairman since 1943 was present at the meeting. This bespeaks interest in the work and the continued loyalty of the former chairmen.

#### Change in West Coast Meeting Officers

Several important changes have been made in the officers of the Committee on Arrangements for the 1956 meeting in Los Angeles, September 16–22.

**Carrol M. Wakeman,** former district chairman and long active in the Society, has been appointed General Chairman, succeeding E. Ord Slater, who found it necessary to be relieved of this responsibility although he will continue serving on the committee and participate in so far as possible. Mr. Slater was appointed an Honorary Vice-Chairman, serving with Messrs. W. M. Barr, E. O. Bergman, P. V. Garin, and H. P. Hoopes.

**Fred B. Doolittle,** Electrical Engineer, Southern California Edison Co., has been appointed Chairman of Plant visits, succeeding J. B. Morey now located in Cincinnati.

**C. E. Emmons,** chairman of the Finance Committee, has been appointed Treasurer of the General Committee since it was felt this action would simplify operations.

**P. James Rich,** Technical Director, Kwikset Locks, Inc. and Consulting Chemist, has accepted appointment as chairman of the Technical Program Committee, succeeding Professor F. J. Converse who regretfully resigned from this post but will continue on the Program Committee.

**Myron B. Niesley** will continue as General Committee Secretary, it being understood that much of the spade work for the meeting will take place in the various subcommittees.

### New Home for Forest Products Research Society

The Forest Products Research Society will begin construction of its new executive office building in June at Madison, Wis. The site is located in a growing research center at the west edge of the University of Wisconsin campus near the U. S. Forest Products Laboratory.

The building will combine many of the newest and latest forest products materials and techniques in existence at the present time.

# Technical Committee Notes

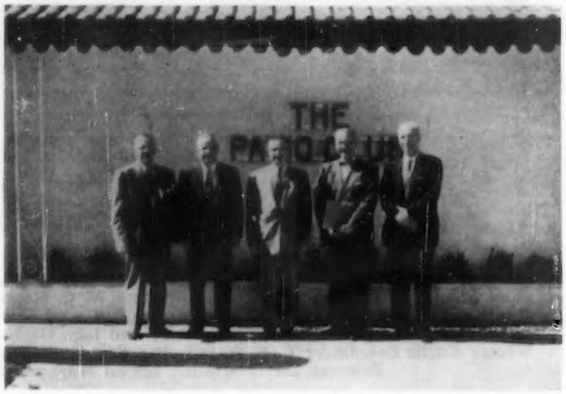
***Activities of the ASTM technical committees which met in Cincinnati during the Society's Committee Week, January 31 to February 4, are summarized on these pages. For convenience, other committee meetings held recently in other cities are also included in this report.***

## Thermal Insulating Materials

***Problems of Moisture Receive Special Attention***

THE related subjects of the effects of moisture, vapor barriers, and coatings received prominent attention at the March 2, 3, 4 meeting of Committee C-16 at the General Oglethorpe Hotel, Savannah, Ga. Although surrounded by a typical southern environment of azaleas in bloom and summer-like temperature, a concentrated schedule of meetings attended by over 70 persons was completed during the three-day period.

A very encouraging report on the effect of moisture on thermal insulation was presented at an evening session when the research program at Pennsylvania State University was reviewed by Professor F. A. Joy. A second solicitation of funds needed to continue this project was generously subscribed by industry, thus reflecting the support and interest in this activity.




**Members of ASTM Committee C-16, photographed at the Georgia meeting, are, left to right: W. H. Zane; W. L. Scott; E. R. Queer, Chairman; E. C. Shuman; and W. L. Gantz, Secretary.**

The Subcommittee on Vapor Transmission, after reviewing data on a round-robin series of tests on permeance of vapor barriers for industry use, authorized a second test series in order to obtain additional needed information. Additional methods of measuring water vapor transmission are being studied, one being the Armstrong Cork Method.

The newest activity relating to water vapor barriers is a program under the Subcommittee on Coatings. The activity in this field is concentrating on bituminous coatings at present. Exploratory tests on cut-back and emulsion-type asphalts have been made to establish fire test data, using both supported and unsupported films. Further tests using a $\frac{1}{8}$-in. emulsified asphalt thickness and a $\frac{1}{8}$-in. wet thickness of cut-back asphalt will be used. Five laboratories will participate in additional tests using a standard-size panel of calcium silicate block type thermal insulation, and keeping information on source, temperature, and duration of flame test. The effect of conditioning on properties of coatings is also under study, and a preliminary report is in circulation.

G. E. Gronemeyer and W. C. Turner have been appointed chairman and secretary, respectively, of a new subcommittee on reflective insulation, the latest field of activity of the committee. The first effort will be to formulate a definition of reflective insulation which will serve as a guide in establishing a scope for the group.

The need for differentiation between the thermal insulating cements and finishing cements was considered necessary as a result of suggested specifications being developed for mineral wool finishing cements. The Subcommittee on Thermal Insulating Cements will report at the next meeting on a possible definition, types, and scope for finishing cements. As a further result of this discussion, indicating the need for definitions of other general terms including "thermal insulating materials," a new Subcommittee on Nomenclature and Definitions was authorized with E. C. Shuman as chairman. This subcommittee will review all present definitions now included in the ASTM C 168 but also those definitions found in other specifications and test methods under the jurisdiction of the committee.

Three additional specifications for preformed thermal insulation were reviewed for subcommittee ballot; a proposed specification for cellular glass thermal pipe insulation, proposed specification for mineral wool block or board insulation for elevated temperatures, and a proposed specification for mineral wool block or board insulation for low temperature. One additional specification is also being put into draft form for blanket material for use at elevated temperatures. A draft of a specification for blanket insulation for building purposes will be prepared and circulated by the next meeting. Good progress has been made on a proposed test method for determining the density of loose-fill building insulations by the jolting impact method.

Methods of tests for determining maximum use temperature of high temperature thermal insulation has been considered in the form of a single proposed standard originally including procedures for measuring linear shrinkage, hot surface performance, and emissivity. Inasmuch as the linear shrinkage test has already been separated and presented to the committee, it was agreed to separate the several determinations under individual ASTM designations. An emissivity test method is now in draft form for circulation to the subcommittee. Further tests will be conducted by several subcommittee members to ob-

tain test data on a maximum use-temperature test procedure. An additional shrinkage test method for determining shrinkage under soaking heat on loose fill-batt insulation will be prepared for consideration at the next meeting.

## Wood

### *Dinner Celebrates 50th Anniversary in Chicago*

COMMITTEE D-7 on Wood commemorated its 50th Anniversary on March 16 during its two-day meeting held in Chicago in conjunction with the meetings of the American Railway Engineering Assn. Two days of subcommittee and main committee meetings were culminated with a Golden Anniversary Dinner sponsored jointly by the Chicago District Council of the Society and Committee D-7. A very interesting program was presented with L. J. Markwardt, present chairman of Committee D-7, as toastmaster. Greetings from the Society were given by C. H. Fellows, Senior Vice-President.

The highlights of the program were the history of Committee D-7, (see page 40) given by Past-President W. H. Fulweiler, one of the oldest members of the committee, and a highly interesting talk entitled "An American Paradox," by Paul R. Leach, Jr., Public Relations Department, the du Pont Company. Commemorating the occasion was a souvenir distributed to all present in the form of a small compressed block of western maple, suitably inscribed, furnished by the West Coast Lumberman's Assn.

The Tentative Methods for Establishing Structural Grades of Lumber (D 245) were reviewed in completely revised form by Subcommittee I. As a result of this consideration, the final draft will now be prepared for subcommittee letter ballot. The revisions center around new information compiled on stress grading and working stresses. The Tentative Specifications for Round Timber Piles (D 25) was recommended for adoption as standard without change. A revision of the Specification for Creosoted End-Grain Wood Block Flooring for Interior Use (D 1031), accepted for immediate adoption, will provide an alternate provision of four annual rings per inch and a revision of a reference to the coal-tar pitch requirement.

A comprehensive report was given on the wood pole testing program being conducted at the Forest Products Laboratory under the direction of Subcommittee VII on Wood Poles. It was indicated that tests have been completed on western larch, southern yellow pine, and Douglas fir species. Tests in process include lodgepole pine and western red cedar species. Technical reports are being prepared on the Douglas fir test and on a comparison of the crib *versus* machine test methods (D 1036). Revisions of Method D 1036 were recommended and accepted, subject to letter ballot, as a result of this extensive use of the test methods in the program. These changes will affect the moisture determination procedure mainly.

A development in the testing of wood for measuring durability was indicated in the consideration of a soil block method of test being developed for the evaluation of wood preservative treatment. This is a rapid method, in which two weeks of testing represents four months of actual weathering. The Subcommittee on Wood Preservatives is now considering specifications for various salt preservatives. Revisions of the Tentative Methods of Test for Evaluating the Properties of Building Boards (D 1037) are under consideration which would include additional procedures for evaluating nail head pull-through, block shear, glue line shear, and falling ball impact. A group of definitions pertaining to hardboards is currently being reviewed.

A tentative program of papers to be presented at the Los Angeles meeting of the Society in September 1956 was outlined. It will include the subjects of new structural uses of timber, earthquake resistance, statistical evaluation, and a review of the wood pole testing program.

In his talk at the Committee D-7 Dinner, Mr. Leach stressed four basic factors of production as the secret of this country's ability to unlock the door to production. Quoting Mr. Leach, "they are raw materials, manpower, tools, and motivation. It is only by bringing out new things, before the other fellow, that we can hope to keep ahead. To hold back when we have something new would be fatal; it would deny the whole purpose of the research program on which du Pont is now spending $57 million a year."

## Electrical Insulating Materials

### *Electrodes Symposium Featured at Washington Meeting*

A PARTICULARLY lively discussion followed papers on the air-gap method for dielectric measurements presented by R. F. Field and Tom Hazen at the Symposium on Electrodes held on March 3 during the Washington (D. C.) meeting of Committee D-9. Evidence was presented to show that a test method based on an air-gap or, in effect, a missing electrode may obviate many of the difficulties inherent in placing an electrode in intimate contact with the test specimen. Other types of electrodes considered in the symposium were of metal foil, and electrodeposited and sprayed metal. Although the proceedings of the symposium are not to be published, a limited number of copies of abstracts will be made available.

A symposium on the corona phenomenon in electrical testing is planned for the fall, 1955 meeting.

Three revisions, approved by committee letter ballot, were made in Methods of Test for Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies (D 149), Methods of Testing Pressure-Sensitive Adhesive Tapes Used for Electrical Insulation (D 1000), and Methods of Testing Varnished Cloths and Varnished Cloth Tapes Used for Electrical Insulation (D 295). The revised methods will appear in the new book of standards to be published this year.

Activities of the Task Group on High-Power Arc Resistance Tests were reported, supplementing the report given at the Cleveland meeting in November. A program for developing a suitable test has been outlined and work is in progress. It is expected that definite results can be reported at the June meeting. The existing method for low-current arc resistance (D 495) is being studied with a view to improving the reproducibility. At the meeting, G. R. Radley demonstrated a modified arc test apparatus, the details of which are to be submitted to the section for consideration in the proposed revision of Method D 495.

Subcommittee IV on Liquid Insulation is in process of reorganization with the objective of improving efficiency of operation. The new plan envisages smaller and more efficient working groups and the discharge of some inactive sections.

It was noted that standardization of viscosity testing of insulating varnishes is badly needed, a survey having shown that among 21 organizations, 18 different viscosity test methods were being used. It was recommended that the assistance of the appropriate group of Committee E-1 on Methods of Testing be solicited for standardization of the viscosity method for insulating varnish.

## Textile Materials

### *Dillon Receives Smith Medal at Well Attended Meetings*

COMMITTEE D-13 held a very productive four-day meeting in New York, March 15–18, attended by 225 members and guests. The highlight of the meeting was the sixth award of the Harold DeWitt Smith Memorial Medal to Dr. J. H. Dillon, Director of Textile Research Inst., at a luncheon held in his honor on Thursday, March 17. A very comprehensive and scholarly summary of Dr. Dillon's contributions in advancing the science of textile technology was presented by A. G. Ashcroft, Vice-President and Director of Research, Alexander Smith, Inc.

Further reference with regard to the award of the Smith Medal is given in this BULLETIN on page 29.

In Subcommittee B-1 on Test Methods action was taken to submit for publication as information only Proposed Methods of Test for Determining Fiber Weight per Unit Length by the Vibroscope. Interlaboratory test studies of these methods are being continued. Draft of a proposed method of test for crimp of fibers has been completed and is under study by a task group. Methods of test for determining unevenness of yarns are in preparation. It was decided to submit to the entire membership of the subcommittee a questionnaire on stretch and recovery of yarns in order to determine the degree of interest and whether work should be initiated on this subject. The cantilever and heart loop methods for stiffness of textile fibers were submitted for publication as tentative. These methods have been prepared after a series of interlaboratory cooperative tests and will conform closely with the Federal Specification Method CCC-T-191b.

Three methods for measuring the restorability of knit goods after laundering are being investigated covering (1) a pneumatic machine with an inflated rubber diaphragm, (2) the tension presser, formerly used for restoring woven rayon fabrics, and which is being used for warp knit fabrics, and (3) an improvement of the machine developed by the Industrial Rayon Corp. A questionnaire will be sent to members of the subcommittee to determine the extent of interest in development of a general method of test for shrinkage of all types of fabrics where temperature is the governing factor, and in the type of fiber used in the fabric. An important addition recommended for the Tentative Methods of Quantitative Analysis of Textiles (D 629) covered new procedures for analyzing mixtures of dacron and wool. Work is now under way on development of similar procedures for determining Acrilan and viscose rayon, also cotton and viscose rayon in fabrics containing these types of fibers. The first revision of the Tentative Methods of Test for Abrasion Resistance of Textile Fabrics (D 1175) since they were issued in 1951 was presented. Based on cooperative tests and experience with the methods, changes will be recommended in Method B on Flexing and Abrasion. Methods for determining thermal transmission of textile fabrics are being investigated and it is hoped to have a tentative procedure completed at the October meeting.

The Subcommittee on Ultimate Consumer Textile Products presented tentative methods of test for determining the pilling tendency of textile fabrics which will include four procedures that have been under cooperative test study: (1) du Pont Pilling Tester, (2) Celanese adaptation of the Stoll Machines, (3) pilling resistance, developed by the U. S. Testing Co., and (4) appearance retention tester, developed by the U. S. Navy. Evaluation of pilling of fabrics is a complex problem, and the committee is continuing its cooperative laboratory studies. Tests completed to date indicate that these four methods give satisfactory reproducibility. Methods of testing elastic fabrics have been completed and will be recommended as tentative following committee letter ballot approval.

Test methods and nomenclature for slide fasteners are under study in cooperation with the Slide Fastener Assn. Preliminary inquiries have indicated interest in development of test methods for determining seam characteristics such as seam slippage, needle cutting, etc. A task group was authorized to proceed with this subject. A new task group was also organized on methods of test for resiliency and thickness of blankets using the Compressometer.

The Subcommittee on Cotton Fibers reported completion of several methods to replace those now appearing in the Tentative General Methods of Testing Cotton Fibers (D 414). These include a revised method of test for maturity of cotton fibers by polarized light, also a new method of test for strength at finite gage length. The Method of Test for Length of Cotton Fibers by Fiber Array (Suter-Webb Method) was recommended for adoption as standard with editorial changes.

The Proposed Method of Test for "Fineness" of Cotton Fibers by Resistance to Air Flow (Arealometer Method), published as information for the past two years, was recommended for acceptance as tentative. The Methods of Test for "Neppiness," appearing in Methods D 414, are being withdrawn. This procedure is no longer necessary, in view of the Tentative Method of Test for Number of Neps in Cotton Fibers (D 1446). At the meeting of the Cotton Subcommittee a paper was presented by Prof. K. L. Hertel, University of Tennessee, describing the "Speedar," a new instrument for measuring cotton fiber fineness which apparatus will be studied by the committee.

The Subcommittee on Non-Woven Fabrics received reports on the following subjects: (1) abrasion resistance, (2) delamination resistance, (3) wash resistance, and (4) crease resistance and launderability. A proposed test for permeability has been completed and submitted to letter ballot. A well-attended meeting of the Section on Wool received reports from the following task groups: (1) nep count, etc., in sliver and top, (2) extractable matter in wool, (3) tensile strength wool fiber in bundles, (4) average fiber diameter of wool by porous plug tester, (5) moisture determination in wool fiber and top, (6) fiber length of wool, (7) fineness of wool and wool tops, (8) fineness standards for mohair, (9) core sampling of wool, accumulation of statistical data, (10) clean wool content in wool in the grease, commercial scale, (11) vegetable matter in scoured wool, (12) evenness of wool sliver and top.

The Subcommittee on Asbestos Textiles reviewed a new chemical method for determining asbestos in materials containing other fibers. The use of the combustion method as a referee test for asbestos analysis was discussed. A report on the significance of magnetic iron in asbestos textiles was also presented.

The Subcommittee on Warp Knit Fabrics has made excellent progress. It presented for publication as tentative methods for determining yield and related properties of warp knit fabrics which will cover the following four procedures: (1) yield method, (2) weight method, (3) wale and coarse count, and (4) invoice width. Proposed Methods for Determining Strength and Related Properties were submitted for publication as information. Studies of snag resistance, dimensional changes (shrinkage), and preparation of nomenclature and definitions are continuing.

The Subcommittee on Bast and Leaf Fiber Products took action on a proposed test for mercantile conformance, and also for knot breaks in yarn and twine. The Subcommittee on Tire Cord and Fabrics took action on an extensive revision of the Tentative Methods of

Testing and Tolerances for Rayon Tire Cord (D 885).

The Subcommittee on Felt discussed the following tests: (1) stiffness, (2) mildew resistance, (3) water abrasion, (4) synthetic fibers in felt, (5) heat stability, and (6) water absorption.

The Subcommittee on Pile Fabrics gave detailed consideration to a flammability test for carpets. Further studies are being continued, and it is hoped to complete this method within the next six months. Test methods for tufted pile floor coverings are being actively investigated, including procedures for (1) soiling, (2) fastness of color to light, and (3) rubber backing tests. A comprehensive list of definitions and nomenclatures applying to these fabrics is in preparation, and it is expected that a draft will be available at the next meeting.

The Section on Cotton Yarns received a very interesting report from a task group appointed to study the Tentative Methods of Testing and Tolerances for Cotton Yarns (D 180) which recommended that work be undertaken immediately looking toward the complete revision of the methods which should result in a more comprehensive set and useful series of test procedures for cotton yarns.

## Engine Antifreezes

### *Work Progresses on Rubber Immersion Tests*

The fourth collaborative rubber-immersion test series was reported and discussed at the annual meeting of Committee D-15 held in Washington, D. C., March 23 to 25. This series of tests was undertaken by twelve laboratories, testing three types of rubber hose immersed in 15 types of engine antifreeze coolants. The several hundred test results from this series will form the basis of recommendations for a bench type of test method.

The glassware corrosion test for engine antifreezes has been intensively tested for over three years in an effort to produce a reliable procedure for screen testing of antifreezes. A proposed method of corrosion test will be presented at the Society's Annual Meeting.

A revision of the specifications for hydrometer-thermometer field tester was discussed at length. These revisions reflect the present manufacturing practices of the glass industry. Further discussion was centered around several new direct reading thermometer field testers now on the market. A study group was appointed to investigate these testers.

The Tentative Method of Test for Water in Concentrated Engine Antifreezes by the Iodine Reagent Method (D 1123) was reviewed in the light of a new solvent for the Carl Fischer reagent. A study of this new solvent used for antifreeze testing will be initiated and recommendations are expected to be made as soon as possible.

## Plastics

### *Flow and Dynamic Modulus Studies Reported at Meeting*

An important and interesting feature of the recent meeting of Committee D-20 was the symposium held in the evening of March 1 following the second day of subcommittee sessions at the Shoreham Hotel in Washington, D. C. The program, arranged by A. G. H. Dietz, chairman of Subcommittee VIII on Research, included reports on investigations in England and Canada as well as in the United States on several subjects as follows:

- Dynamic Modulus Measurements by the Vibrating Reed Method—*G. R. Rugger, U. S. Department of the Army, Picatinny Arsenal*
- The Crazing of Polystyrene—*E. E. Ziegler, Dow Chemical Co.*
- The Flow Behavior of Molten Polyethylene—*A. M. Birks, Canadian Industries Limited, McMasterville, Quebec, Canada*
- Characterization of Polyethylene—*W. G. Oakes, Imperial Chemical Industries Ltd., Northwich, Cheshire, England*

Explaining that a dynamic speaker-voice coil arrangement was used for actuating vibration in a plastic sample, Mr. Rugger showed how the resonant frequency, band width, dimensions of vibrating specimen, and known physical constants of the material are used to calculate the elastic and the inelastic components of modulus. Comparing the plastic material with a Voigt model—that is, a spring and dashpot in parallel, he indicated the nature of these components.

Mr. Ziegler reported studies on the factors which influence crazing of polystyrene. It was shown that crazing is a time effect and is strongly influenced by conditions of temperature and exposure to certain reagents. The surface stress levels at which crazing occurs can be predicted with considerable accuracy if environmental conditions are known.

The papers on polyethylene revealed some interesting flow phenomena as influenced by the shear rate during extrusion of polyethylenes of different melt viscosities. It was found that above a certain rate of extrusion, a critical rate of shear occurs which adversely affects product quality. The problems relating to the characterization of various polymers of ethylene were discussed.

During the technical sessions, a subject of discussion was plastic pipe. The joint ASTM-SPI subcommittee on the subject had included in its scope the formulation of test methods and specifications for plastic pipe. What had not previously been clear was whether or not specifications included dimensions. Following the discussions and on a basis of a recommendation from the subcommittee, the Committee on Plastics agreed that the scope would include dimensions as a part of plastic-pipe specifications.

Reinforced plastics standardization got off to a good start with attention being given to epoxy-glass fiber laminates and translucent panels for structural and glazing purposes. Drafts of specifications for these materials are being prepared. Work is also in progress to prepare draft specifications for the resins and reinforcements used in reinforced plastics.

## Paul G. Agnew Foundation

In order to carry forward the work of the late Paul G. Agnew—for over 30 years the directing head of the American Standards Association and its predecessor, the American Engineering Standards Committee—a group of his friends who had worked closely with him have undertaken to create the Paul G. Agnew Foundation. The organizing committee, consisting of Howard Coonley, chairman, Harold S. Osborne, Samuel P. Kaidanovsky, Sidney K. Wolf, and G. F. Hussey, Jr., has decided that its initial efforts shall be the arranging of a series of lectures on standardization to be given at engineering schools. In the first year a series of ten lectures will be given—five by Dr. Osborne and five by Rufus E. Zimmerman.

Dr. Osborne, formerly Chief Engineer of the American Telephone and Telegraph Co., is currently president of the International Electrotechnical Commission. Dr. Zimmerman, formerly vice-president of the United States Steel Corp., is a past-president of the ASA.

Under the personal direction of Mr. Coonley, fund raising has been undertaken and half of the amount estimated as necessary for the first two years has already been obtained. These funds will be used to pay the expenses of the lecturers and incidental expenses of administration.

# 50 Years of Committee D-7 on Wood

## By W. H. Fulweiler

*Seventh to join the group of ASTM technical committees that have reached their fiftieth birthday, is Committee D-7 on Wood.*

*Some of the achievements of this group and its distinguished leaders are chronicled here by W. H. Fulweiler who briefly reviewed the committee's history at the anniversary dinner in Chicago (see page 37).*

FIFTY years ago a group of twelve men gathered under the chairmanship of Dr. Hermann von Schrenk to organize the first ASTM committee in the field of wood. This committee, known as Committee Q on Standard Specifications for the Grading of Structural Timber, had as its purpose the study and analysis of the grading of structural timbers, so as to arrive at a general understanding of the qualities of the various woods used for structural purposes. Early objectives were to define structural timbers, standardize trade names of wood, and to establish principles of inspection and grading.

Cooperation and joint meetings with lumber groups and the American Railway Engineering and Maintenance of Way Association were an early part of committee work. In 1910 Committee Q became Committee D-7. Committee activities were gradually expanded to include preservative treatments, wood paving blocks, methods of testing, and interpretation of test results. Expanding objectives led to a change in name in 1916 to Committee D-7 on Timber at which time the membership totaled 37. In 1922, standard methods of testing small clear specimens of wood and methods of testing timbers in structural sizes were developed. These methods have served as a basis for evaluating the properties of the important American woods and are also employed in other countries.

In 1945, in view of the new developments and products from wood, the committee was reorganized, its scope and functions were broadened, and the name was changed to Committee D-7 on Wood. New subcommittees were formed and membership and activities grew. New subcommittees brought expanded interests, and work on plywood, laminated timber, modified woods, fire-retardant wood, chemical composition of wood and structural fiberboards became part of committee activities, until at present 84 members and 26 consulting members are concerned with the work of 15 subcommittees.

Hermann von Schrenk

### Place in the Society

There have been many changes in the title and scope of ASTM committees. In some cases several committees have been consolidated. Of the existing committees only six were formed earlier than Committee Q, or D-7, on Wood. These are: A-1 on Steel, originally Committee A, formed in 1898; C-1 on Cement, originally Committee C, formed in 1902; D-1 on Paint, originally Committee E, formed in 1902; A-3 on Cast Iron, originally Committee B, formed in 1903; A-6 on Magnetic Materials, originally Committee G, formed in 1903; and D-4 on Roads, originally Committee H, formed in 1903.

### Membership

Of the 12 men who formed the original committee, none are still living. When Committee D-7 was reorganized in 1914 there were thirty-two members. Of these, A. L. Kuehn, now president of the American Creosoting Co., and W. H. Fulweiler are the only two members still active on the committee. However, there are seven organizations who were represented on the committee in 1914 still retaining active membership. These are: The Associated Factory Mutual Fire Insurance Companies; The Barrett Division, now of the Allied Chemical and Dye Corp.; The Chicago and Northwestern Railway Co.; Forest Products Laboratory; The New York Central Railway Co.; The Department of the Navy; and The Yellow Pine Manufacturers Assn., now The Southern Pine Assn. There is another long-time member whose name should be recorded—Prof. C. E. Paul of the Illinois Institute of Technology, who joined in 1923 and who, although in retirement, is still an active member of the committee.

Four members of Committee D-7 have been presidents of the Society: W. H. Fulweiler (1925); Cloyd M. Chapman (1932); Hermann von Schrenk (1934); and L. J. Markwardt (1950).

Five members have been elected to honorary membership in the Society, namely, Cloyd M. Chapman, W. K. Hatt, C. S. Reeve, Hermann von Schrenk, and W. H. Fulweiler.

### Officers

Committee D-7 has had the distinction of having had relatively few officers—a grand total of only five men having served over the fifty-year period. Dr. Hermann von Schrenk was the original chairman and served 44 years consecutively until 1948, when he was made honorary chairman and was succeeded by the present chairman, L. J. Markwardt. It has had only four secretaries: Prof. W. K. Hatt (1906–1915); J. A. Newlin (1915–1943); L. J. Markwardt (1943–1948); and L. W. Smith (1951 to date).

### Accomplishments

In the fifty years that Committee D-7 has been active it has developed some 48 standards: four specifications, seven physical tests, ten chemical tests, and three lists of definitions on wood; and four specifications, nine physical tests, six chemical tests, and one list of definitions on wood preservation and wood preservatives.

It is interesting to note that Committee D-7 was never able to carry out successfully its original assignment, that is, standard specifications for the grading of structural timber. It started off valiantly by appointing subcommittees to develop definitions of structural timber, standardization of trade names, and grading. In their early preliminary report they hoped that eventually their work might develop into a handbook covering these subjects. It soon developed, however, that many of these

subjects were highly controversial by nature and it was apparently very difficult to arrive at unanimity within the committee, as well as correlation with the work of similar committees from other organizations engaged on the same subjects. Among the difficulties that had to be overcome were the identification of long-leaf yellow pine *versus* short leaf; the effect of density; rings per inch; and the variation in trade and botanical names.

One of the earliest standards was D 9–07 on Definitions, a portion of which still exists as D 9 – 30. The most recent attempt at the original objective is the Tentative Basic Principles for Establishing Structural Grades of Lumber (D 245–49 T). Early specifications also included Round Timber Piles (D 25), first appearing in 1915, and a specification for Wooden Paving Blocks for Exposed Pavements (D 52), published initially in 1918.

While the committee had a difficult time with some of the early specifications they were more successful in their methods for testing. For example, testing of small, clear specimens of timber (D 143) has received international recognition. These methods were largely developed at the U. S. Forest Products Laboratory. Tentative Methods of Test for Evaluating the Properties of Building Boards (D 1037) and Methods of Test for Plywood, Veneer, and Other Woods and Wood-Base Materials (D 805) have also received international recognition. In 1954 a 356-page compilation of the 48 current standards developed by Committee D-7 plus seven related standards was published in a single volume.

The history of Committee D-7 would not be complete without paying some tribute to three of the officers, now deceased, who did so much to carry forward the work of the committee.

**Hermann von Schrenk** was chairman of the committee for 44 years, joining the Society in 1903. He was president of the Society during 1934–1935, was made an honorary member in 1944 and honorary chairman of Committee D-7 in 1948, prior to his death in 1953. Mr. von Schrenk was a man of tremendous energy, interested in everything pertaining to wood and with an international reputation and acquaintanceship with wood technologists all over the world. He was a hard man to keep up with when he was interested. He never walked—he ran. It was his insistent drive and enthusiasm that kept the committee going during the early years.

**W. K. Hatt** was professor of dynamical engineering at Purdue University. He was an enthusiastic and vigorous worker in a number of fields and his engineering knowledge was of great assistance to the committee. Dr. von Schrenk and Professor Hatt made a wonderful team.

**J. A. Newlin** joined the Society in 1913 and was secretary of the committee from 1915 until his death in 1943, apparently a longer period than the secretary of any other ASTM committee. Mr. Newlin spent most of his life at the U. S. Forest Products Laboratory where he was engaged in mechanical testing of wood and wood products. As previously mentioned, his work was largely responsible for the development of methods of physical testing of wood. Mr. Newlin was a quiet, unassuming man; an expert in his field; and a most painstaking secretary. It is interesting to note that his son, C. H. Newlin, who is now connected with the Southern Railway Co., is one of the consulting members of Committee D-7.

## More on Plastics Committee Expansion

Supplementing reports in previous issues of the Bulletin, Committee D-20 on Plastics has completed the organization of sections under five new subcommittees. More members, especially those in the consumer classification, are needed and it is suggested that those interested in working with the sections listed below write to G. M. Armstrong, Secretary, Committee D-20 on Plastics, Tennessee Eastman Corp., Kingsport, Tenn., so that their interest can be brought to the attention of the sections concerned.

### Subcommittee XV on Thermoplastic Materials

*Scope:* The development of methods of test and specifications for thermoplastic materials including molding compounds, resins, and plasticizers. Sections are as follows: A—Vinyl Plastics, B—Acrylic Plastics, C—Styrene Plastics, D—Cellulose Nitrate Plastics, E—Cellulose Acetate Plastics, F—Cellulose Acetate Butyrate Plastics, G—Ethyl Cellulose Plastics, H—Resins, I—Nylon Plastics, J—Ethylene Plastics, K—Plasticizers, and L—Halocarbon Plastics.

### Subcommittee XVI on Thermosetting Materials

*Scope:* The development of methods of test and specifications for thermosetting molding compounds. Sections are as follows: A—Phenolic Molding Materials, B—Amino Resins, C—Allyl Plastics, D—Polyester Molding Materials, and E—Polyester Laminating Resins.

### Subcommittee XVII on Plastic Pipe and Fittings (Joint with SPI)

*Scope:* The development of methods of test and specifications for plastic pipe and fittings (extruded, reinforced, and laminated constructions). Sections are as follows: A—Polyvinyl Chloride Plastics, B—Cellulose Acetate Butyrate, C—Polyethylene, D—Styrene Plastics, E—Reinforced Plastics, F—Bursting Strength, G—Long-Time Creep, and H—Fittings (Polyethylene: Solvent-Welded and Threaded).

### Subcommittee XVIII on Reinforced Plastics

*Scope:* The development of methods of test and specifications for reinforced plastics, excluding plastic pipe and fittings. Sections are as follows: A—Flat Sheets, B—Rods and Tubes, C—Corrugated Sheets, D—Laminating Resins, and E—Reinforcements.

### Subcommittee XIX on Plastic Film and Sheeting

*Scope:* The development of methods of test and specifications for plastic films and sheeting (rigid, semirigid, and nonrigid). Sections are as follows: A—Vinyl Plastics, B—Ethylene Plastics, C—Cellulose Plastics, D—Acrylic Plastics, and E—Styrene Plastics.

## Laboratory Course in Electron Microscopy

The Summer Laboratory Course in Techniques and Applications of the Electron Microscope will be given again this summer by the Cornell University Laboratory of Electron Microscopy, Department of Engineering Physics. The course, under the direction of Prof. Benjamin M. Siegel, will have Profs. Cecil E. Hall of Massachusetts Institute of Technology and Robley C. Williams of the University of California, and is designed to give members an intensive survey of basic theory and interpretation of results. Registration is limited to a small group so that ample facilities are available for each one to pursue laboratory work in his special field at an introductory or advanced level.

Further information can be obtained from Professor Siegel, Rockefeller Hall, Cornell University, Ithaca, N. Y.

# Random Samples...

## FROM THE CURRENT MATERIALS NEWS

*From the broad stream of current materials information flowing from "in-box" to "out-box" in a busy editorial office, random samples (mostly random) have been plucked. Thinking them worth re-showing to ASTM'ers who may have missed the original articles, we have included them here. Of course, we had to trim the samples to fit. There will be those who are not satisfied with samples, especially ones which are not really random. But these ASTM'ers can contact the institution, magazine, governmental agency, etc., who placed the original information in the stream, or address Random Samples, ASTM, 1916 Race St., Philadelphia 3, Pa.*

EDITOR'S NOTE.—Last month in this column, through an unfortunate error, the credit line for the item on "Mummy Paper" was omitted. This appeared in the February, 1955 issue of *The Betz Indicator*, The W. H. and L. D. Betz Co., Phila. 24, Pa.

### Nuclear Steam Generators Anticipated for Open Market

PLANS for the construction of what is believed to be the first privately financed major plant for the manufacture of fuel elements and other reactor core components for the nuclear power industry, were announced by the Atomic Energy Division of the Babcock & Wilcox Co. The plant, to be located about five miles east of Lynchburg, Va., is expected to be completed by the end of the year.

This company announced last year that it anticipates making complete nuclear steam generators for the production of electric power. The company has already developed and fabricated special equipment for many of the major atomic energy installations. The new plant will provide facilities for the manufacture of many types of special equipment for this rapidly growing industry.

The company designed and built vital equipment for the *Nautilus*, the world's first atomic submarine, and will also furnish much of the equipment used to power the second atomic submarine, the *Sea Wolf*. In addition, the company is supplying much equipment for large nuclear tests in the national laboratories and has developed and placed on the market three low-cost reactors which can be used by colleges and other organizations for research and training purposes.

•

### Assist to Resistance Welding

SCIAKY Brothers, Inc., largest manufacturers of electric resistance welding equipment in the world, are convinced the resistance-welding industry is still in its infancy and has been hampered by a lack of technical information.

As a result, Sciaky has embarked on an aggressive program to develop and disseminate technical data and promote the broader use of the technique of resistance welding. The first phase of this program is now an accomplished fact—establishment of the Western Research Division, 2311 Purdue Ave., West Los Angeles, Calif., for fundamental research on resistance welding of all metals and eventually a thorough exploration of design considerations in all fields.

Beyond the complete facility for metallurgical, chemical, and related investigation, the Sciaky Research Division is completely equipped with a 3000-kva high-voltage bank source of power serving the most advanced resistance welding machines, including the largest in the world today. This equipment can be augmented at any time through the facilities of Sciaky manufacturing operations both in the United States and abroad.

A specialized technical library for industry is being developed. The results of the research activities will be passed on to the industry through the use of periodicals, special bulletins, and conferences.

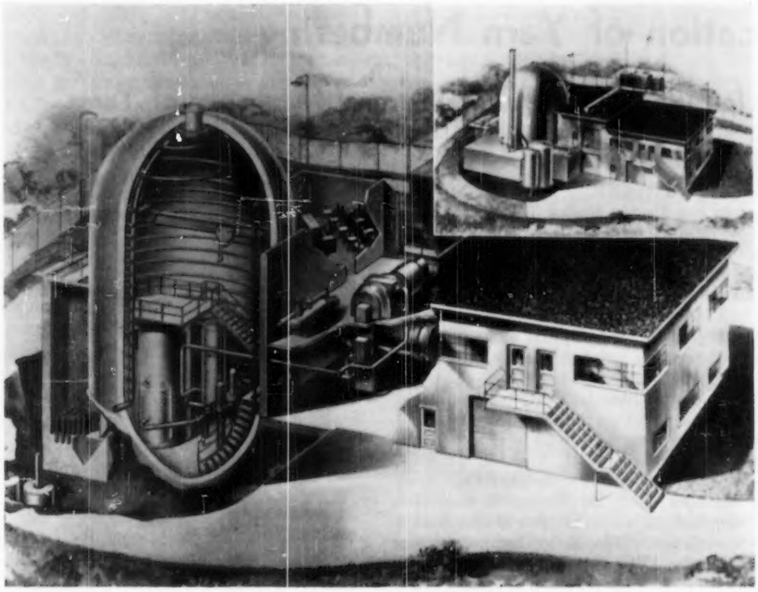
•

### Metal Monsters

A PUSH-BUTTON giant steel press weighing a million and a half pounds, capable of straightening steel plate nearly 2 ft thick, was unveiled at the Lukens Steel Co. by the Clearing Machine Corp. of Chicago, builders of the press. Probably the only one of its kind in the world, the new press has a movable head believed never achieved before with a capacity of 5000 tons pressure. It is the largest movable head flattening press ever built, according to officials of Clearing, a division of U. S. Industries, Inc. Designed to meet unusually exacting specifications, the press will be principally used for straightening armor plate prior to delivery to shipyards. In addition it will be used by the Lukens Steel Co. for commercial purposes. The press makes easy work of flattening plate weighing more than 50 tons. Yet the sensitivity of the controls permit the straightening of a steel plate 20 in. thick, 50 in. wide, and 14 ft long, to within $\frac{1}{2}$ in. tolerance. One unique feature of the Clearing press is the ability of the pressing head to be moved from right to left a total of 160 in. In addition, two motorized cars on either side of the press can shift the steel plate backward and forward so that any area of the plate can be flattened.

A metal monster weighing almost four million pounds and capable of applying 8000 tons pressure for forging metal has begun operation at Aluminum Company of America's Cleveland works. Supplied to Alcoa under a lease arrangement with the U. S. Air Force, it is an important production tool for vital aircraft forgings. It will be valuable too for the production of nonmilitary forgings such as automobile and truck wheels. Among the unusual features of the 8000-ton press are its departure from conventional tie-rod design to increase rigidity and accuracy and its large die area. The 8000-ton press, which was designed and built by United Engineering and Foundry Co., is put together as though it were one giant rigid steel casting. Actually the unit is composed of a number of giant castings joined to act as one. This one casting rigidity permits extremely accurate guiding of forging dies and allows close tolerance work. The rigidity makes it possible to produce difficult unsymmetrical forgings without destroying the alignment of the press or impairing forging tolerances.

"First of the really big ones to get into operation," says Wyman-Gordon Co., announcing the initial production run on its 35,000-ton Loewy closed die forging press at its North Grafton, Mass., plant. The Air Force heavy press program giant is forging aluminum wing spars (about 10 ft long) for the Convair, delta wing, F102 interceptor.



Atomic Package Reactor

proved tube performance when the new graphite is used as anodes in evacuated electron tubes.

•

## *Nuclear Power in a Package*

SHOWN in the accompanying photograph are the first views approved for publication of the Army American Locomotive Co. under a contract received from the Atomic Energy Commission in December, 1954.

The package reactor will be a prototype of the first atom-powered generating plant built so that its components can be transported by air to remote bases in any part of the world. The U. S. Army's first atomic reactor will be erected at Ft. Belvoir, Va., headquarters of the Army Corps of Engineers, and should be in operation in about three years. It will probably be the nation's first exportable peaceful application of atomic energy.

According to Admiral Lewis L. Strauss, chairman of the AEC, the contract is the first of its kind to be let on a fixed-price basis and as such is an important step in the development of power reactor technology.

•

## *Liquid Transistors?*

A LIQUID has been found that behaves electrically like a solid semiconductor. The best known example of semiconduction in a solid is the transistor, a new electronic device replacing the vacuum tube in national defense and industrial electronic equipment. The transistor, made of solids like germanium or silicon, conducts electronically, rather than ionically as in a battery, and the amount of conductance increases with temperature.

This same phenomenon of semiconduction has now been found in liquids—molten metallic sulfides—at Carnegie Institute of Technology Metals Research Laboratory. The discovery was made on an Atomic Energy Commission project dealing with electrochemical studies of nonaqueous melts.

In the case of ordinary salts such as sodium chloride, either molten or in a water solution, electrical current is carried by ions, as in a battery. Exploring less familiar liquids such as those used in metallurgical processes, the researchers uncovered more than they had hoped. The molten liquid sulfides, unlike aqueous solutions or molten ionic salts, behaved like a semiconductor. Instead of conducting electricity by the transport of charged atoms (ionically), it conducted electricity by the flow of electrons as in an ordinary wire. But unlike ordinary metals, the conductance increased with temperature.

Existing theories on the nature of semiconduction cannot account for the new discovery since they apply exclusively to solids such as the transistor and not to liquids when the atoms are in a state of disorder. The discovery may provide a new tool for probing the persistent mysteries of liquid structure.

•

## *High Purity Graphite Grows*

GRAPHITE in diameters up to $2\frac{3}{4}$ in. in diameter, and up to 43 in. in length can be purified to almost the previous level achieved only in small diameter, high purity, spectrographic rods.

A new process developed by the Stackpole Carbon Co., St. Marys, Pa., has resulted in four new high-purity grades of graphite, all of which have a total ash content of 0.003 per cent or less. Purification is carried out as a separate process on completely finished items to eliminate all possible contamination from machining or excessive handling.

Improved machining characteristics and larger sizes of the new grades open up many new fields for the economical use of this exceptionally pure material. Several of the Stackpole high-purity grades have been used successfully as crucibles and boats in the final purification of germanium. As heating elements in electric furnaces, they have shown materially longer life at very high temperatures. Other tests indicate improved tube performance when the new graphite is used as anodes in evacuated electron tubes.

•

## *Athletes, Hunters, and Trucks Subdued*

SAVINGS of an estimated $18,000 per year are in store for the State Highway Department of the State of Virginia as the result of the use of new aluminum highway signs.

Strong arm tactics on the part of self styled athletes accounted for almost seven per cent of the signs damaged last year. Motorists who drive too close to the edge of a road or street and wide trucks that extend past the roadbed are hard on signs. The main cause of damage to signs in Virginia, however, is shooting. Signs are replaced at an annual cost of $40,000 because of marksmen who use them for target practice.

After several tries University of Virginia "strong men" gave up in their attempts to bend the new aluminum signs past the stage of a small amount of giving. Bullet holes through aluminum signs do not cause discoloration as when other metals are used. Because aluminum signs are light in weight and resistant to corrosion, they are easy to store and install and ideal for long-lasting messages which will remain clear and free of unsightly streaking.

# Simplification of Yarn Numbering

## *Germany Prepares for the Introduction of the International Numbering of Yarns*

By Kurt Hentschel

This article* is of general interest to the United States Textile Industry and particularly to those parts of the industry that produce or use yarns made of various fibers. The single universal numbering system for all yarns referred to in the article is intended to displace eventually the confusion of multiplicity of systems now used. This single universal system is advocated by ASTM Committee D-13 on Textiles as indicated in the Recommended Practice for Designation of Linear Density of Fibers, Yarns, and Other Textile Materials in Universal Units (D 861 – 52). The proposal to recognize a series of preferred yarn numbers and to produce other yarns only on special order aims to bring to the textile industry the well-known benefits of simplified practice.

Mr. Hentschel, Chief Engineer of the West German Textile Standardization Committee, has been active in promoting standardization of practices and machinery in the German textile industry. He has written several papers on yarn simplification which have been published in *Textil-Praxis* a leading German textile publication.

The article was translated from the German manuscript by Mrs. Ilse Zeise and has been edited by Dr. A. G. Scroggie, of E. I. du Pont de Nemours, Inc. Dr. Scroggie is chairman of a committee under ASTM Committee D-13 which deals with the international yarn testing methods for the American Standards Association. The latter represents the United States on the Technical Committee on Textiles (TC 38) of the International Organization for Standardization (ISO).

The Technical Committee on Textiles, ISO/TC38, of the International Organization for Standardization resolved in its meeting in Bournemouth, England, in June, 1951, as follows:

> "Technical Committee on Textiles ISO/TC38 reaffirms the proposal to use, for all textile materials, one direct, decimal numbering system, based on metric units, namely, grams for weight and meters for length and their multiples or sub-multiples; the specific units used must be stated in all cases. The combination grams-per-ten-kilometers is designated as a grex. The combination grams-per-kilometer is designated as a tex. It is recommended that member countries encourage the use of this system in their own countries."

While the question of the numbering of yarns has not been discussed again in the Main Committee, the Standards Institute of the Netherlands (Centraal Normalisatie Bureau), which has been designated as the Secretariat of the Subcommittee on "Preferred Series for Yarn Numbers," has attempted, by two circular letters to the 38 countries participating in the ISO committee, to further advance the work assigned to it; namely, to develop a preferred series of numbers for yarn counts in the new numbering system. In the three years since the resolution was adopted at Bournemouth, various branches of the German textile industry have considered the question of the numbering of yarns very thoroughly. The author of this contribution has informed the German textile industry in three articles in *Textil-Praxis*[1] about the previous history of the new numbering system and its details, and has also made some proposals which provoked further discussions in the German textile industry. In these considerations, the question which numbering unit (grex, tex, or other multiples of these units[2]) should be chosen plays only a subordinate role. For the predominant part of the German textile industry only the tex unit is of interest. The chemical (man-made) fiber industry will probably choose the grex unit, since it is closer to the denier unit used heretofore. The selection of a unit will be more difficult for the manufacturers of coarse yarns, for which the author suggested the unit g per 10 m with the abbreviation mex. I want, at this time, to thank Jacques Corbière, who referred in his contribution "The International Numbering of Yarns and Threads,"[3] to an error on my part in the explanation of the unit, "mex," proposed by me. I agree to his suggestion to define the unit "mex" as $10^4$ grex or "myriagrex," equivalent to 1 gram per meter.

The discussions in the German textile industry have shown that the difficulties confronting the introduction in commerce of the new international system of numbering of yarns are not primarily of a scientific but rather of a practical nature. It is not easy to change from the length per unit weight numbering system to the weight per unit length numbering system, when one has thought all one's life in length numbers for yarns. Moreover, it is rather important to examine which individual numbers (or counts) should be used in the new system of weight numbering, because most branches of the German textile industry wish to combine the change to the new system of yarn numbering with a standardization of the production program of the spinning mills on an international basis, if possible. Consequently, two questions must be examined in advance:

1. Is it possible to establish a uniform series of preferred yarn numbers (or counts) for all branches of the textile industry? That was the task which was assigned to the Centraal Normalisatie Bureau and the subcommittee conducted by it.
2. What steps can facilitate for practical men the getting accustomed to the change from a length numbering to a weight number system?

The investigations which the German textile industry has carried out on the question of a preferred series of yarn numbers have shown clearly that it is not possible to select a series of yarn numbers that can be used uniformly by all branches of the spinning industry. Even in the ranges in which the yarn numbers manufactured by the different branches of the spinning industry overlap, the requirements to be met by the fineness of the graduation; that is, closeness of the numbers, differ, so that the establishment of a uniform series of yarn numbers for one industry will never meet the requirements of another industry nor give a basis for a sound standardization of the production program of the spinning mills. On the other hand, it would be regrettable if, at the conversion to the international weight numbering, complete freedom would be allowed in the choice of the yarn counts. The consequence would be that, as is the case now, yarns lying closely together—which are practically the same number, when the unavoidable fluctuations in the actual size made (toler-

* This article also appeared in the February, 1955, issue of the *Textile Research Journal*.

[1] *Textil-Praxis* 9, 660*ff* (1951); 10, 715*ff* (1951); 2, 141 *ff* (1954).

[2] See ASTM Recommended Practice D 861 – 52 T for definitions and further details.

[3] *Textile Research Journal*, No. 12, December 1953.

ances) are taken into consideration—would be designated with different numbers. This consideration led to the search for a numerical series useful for yarn numbers, a series, which is regularly graded at such a fine scale that, even in the case of extremely uniform yarns, for example having only ±3 per cent variation, sufficient numbers are available for the designation of two adjacent yarns. This requirement would be met by a numerical series with an interval between steps of 6 per cent. The complete series would be sufficient to designate, with a permissible variation of ±3 per cent, all yarns which can be differentiated in practice. A series with an interval between steps of 6 per cent has already been standardized internationally—the R 40 series of standard figures. For practical use as a yarn number series, it is possible to round off still further without hesitation, in order to obtain values for yarn numbers that can be handled as easily as possible. Table I gives the values for a yarn number series, which were obtained by rounding off series R 40.

The complete series would not be used by any branch of the spinning industry since, as a rule, larger variations than ±3 per cent must be expected and consequently a coarser gradation in the numerical series has developed in practice. However, it is just as important that numbers other than those given in the numerical table, numbers not required for the purposes of yarn numbering, should not be used. Each intermediate number, for example No. 62 between 60 and 64, or number 29 between 28 and 30, would fall within the range of the tolerance field of the two adjacent

TABLE I.—PROPOSED ROUNDING OFF OF STANDARD FIGURES OF SERIES R 40 FOR THE PURPOSES OF YARN NUMBERING.

| Rounded Values for Yarn Nos. | Rounded Values for Yarn Nos. |
|---|---|
| 10 | 32 |
| 10.5 | 34 |
| 11 | 36 |
| 12 | 38 |
| 12.5 | 40 |
| 13 | 42 |
| 14 | 45 |
| 15 | 48 |
| 16 | 50 |
| 17 | 53 |
| 18 | 56 |
| 19 | 60 |
| 20 | 64 |
| 21 | 68 |
| 22 | 72 |
| 24 | 75 |
| 25 | 80 |
| 26 | 85 |
| 28 | 90 |
| 30 | 95 |
| | 100 |

NOTE: The series of rounded values would be valid also for multiples or sub-multiples of the given numerical values, for example, 22 would be used, also 0.22; 2.2; 220; 2200, etc.

numbers (±3 per cent) and is therefore superfluous. This fact is of fundamental importance for the conversion of the numbering systems used heretofore to the proposed international weight numbering system and for the standardization of the production programs to be combined therewith, as can be seen also from the following considerations on the second question, that is, steps to facilitate getting accustomed to the conversion.

One of the greatest difficulties in the way of introducing the system of weight numbering is that a textile mill man associates a clear concept with specific numbers; for example, with the English cotton yarn No. 20 or the metric No. 34, but not with the number, tex 30. A help to convey the new concepts would be a handy conversion table for the different types of yarn, a table which would show which tex numbers are equivalent to the yarn numbers used up to now. These tables should comprise: Yarn numbers in the metric, English, or any other system used up to now and their converted values; the calculated weight of these yarns, for example in g per km; the rounded numbers corresponding to this weight in a unit of the new international system of weight numbering, for example, tex; and the deviation of the rounded tex-numbers in per cent from the accurately calculated numbers, that is, the weight in g per km. To illustrate this more clearly, a section from a suggested conversion table for cotton yarn numbers is given in Table II.

The conversion tables should comprise as many numbers as possible from the systems used heretofore, also from less customary ones, in order to meet all conceivable requirements. The deviations given in the last column, which result from the use of the rounded tex numbers, are very slight and practically negligible. This too shows that the use of numerical values other than those suggested in the first table is unnecessary for the purposes of yarn numbering, with the exception of a few special cases, which, however, will never be covered by standardization. Separate conversion tables should be set up for each type of yarn, and their use in practice would have the additional consequence that internationally the conversion of the old numbers into the new ones would be carried out uniformly; for example $Ne_B22$, weight 26.84 g per km, is converted to tex 26 and not tex 27, which can be done without hesitation in consideration of the error, 3.1 per cent. Consequently, the No. 27 would no longer be used for yarns in the future.

If the two proposals discussed above should be accepted, namely (1) a rounded series with an interval between steps of 6 per cent, corresponding to Table I, as a future general yarn number series, and (2) conversion tables for the individual types of yarn, which include as corresponding values for the old numbers only the numerical values of Table I in the weight-numbering system, then we could strive for another internation decision which would lead to a gradual introduction of the standard weight numbering. It should be recommended that the spinners, while continuing to use their old numbers, should give the equivalent value of the new weight numbering system in parentheses, numbers which can be taken from the internationally adopted conversion tables. A cotton yarn English No. 20, would be designated "20 (tex 30)," a linen yarn English No. 55 as "55 (tex 30)." A cotton or linen yarn with the metric No. 34 would be designated with the number "34 (tex 30)." This additional information would greatly facilitate the use of the new yarn numbers by the yarn consumer, since by one glance at the information in parentheses on the labels, packages, bills, etc., he can learn the corresponding yarn numbers of different numbering systems and obtain simultaneously with the tex-number the weight of the yarns in g per 1000 m (the number in other corresponding units, for example, grex units—weight in g per 10,000 m).

The above proposals have been sent by Germany to the Netherlands Standardization Bureau, the Secretariat for the Subcommittee on "Preferred Series of Yarn Numbers," with the request that it be considered by the subcommittee.

TABLE II.—SECTION FROM SUGGESTED CONVERSION TABLE FOR COTTON YARN NUMBERS.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Metric No., Nm | English No., $Ne_B$ | French No., $N_f$ | Weight, g per 1 km | tex | Deviation (tex—g per km) per cent |
| 33.87 | *20* | 16.93 | 29.53 | 30 | +1.6 |
| *34* | 20.08 | *17* | 29.41 | 30 | +2.0 |
| 35.56 | *21* | 17.78 | 28.12 | 28 | −0.4 |
| *36* | 21.26 | *18* | 27.78 | 28 | +0.8 |
| 37.25 | *22* | 18.63 | 26.84 | 26 | −3.1 |
| *38* | 22.44 | *19* | 26.32 | 26 | −1.2 |
| 38.95 | *23* | 19.47 | 25.68 | 26 | +1.2 |
| *40* | 23.62 | *20* | 25.00 | 25 | ±0 |
| 40.64 | *24* | 20.32 | 24.61 | 25 | +1.6 |

# The Bookshelf

## Color in Foods

**Advisory Board on Quartermaster Research and Development, Committee on Foods, Quartermaster Food and Container Inst., 1819 W. Pershing Rd., Chicago, Ill., 1954, 186 pp., gratis.**

THIS symposium is a comprehensive and well-balanced report of the status of colorimetry used for the measurement and specification of quality of foods.[1] Some might question its importance to ASTM, originally concerned strictly with engineering materials. To this reviewer, the answer is that this use of color may be considered an inevitable consequence of our ever more integrated civilization, in which the fuel for manpower can be a major factor in our national efficiency, at peace or at war. Recall that the logistical importance of food was perhaps first registered by Napoleon's comment, that an "Army travels on its stomach."

This meeting of leaders in food research was called to review and encourage study of methods for measuring color as an index of food quality. It succeeded in presenting a number of impressive papers and in soliciting comments ranging over the entire problem. The papers were grouped under these headings: Color and Its Relationship to Food Investigations, Color Measurement in Relation to Commodities and Consumer Interest, Instruments for the Study of Color, Measurement of Color, and Color Differences in Relation to Quality. In retrospect an outline more meaningful to this reviewer might have stressed the (1) validity of color as an indication of quality limitations, (2) applications of methods of measuring color in foods, and (3) the chemistry of color and color-changes in food.

The value of this symposium might have been enhanced if a summary had been developed to place in proper perspective some of the divergent views expressed. There seems to be some lack of clarity about the extent to which color is a reliable determinant of food quality. As to being a reasonable measure of maturity of specific foods, there can be no doubt. This is apparently a powerful tool in selecting, processing, storing, and selling foods, toward upgrading their quality and value. But the issue becomes confused when aspects other than appearance, such as taste, are involved. It would seem that the distinction between the consumer's initial or impulse preference and his repeated selection needs further study.

To the color-technician some of these papers will be highly valuable. They show how the pressure for utility in the field has led to the development of simple, rapid, and inexpensive instruments in contrast to the costly, immobile, and relatively complex types necessary for basic research in this area. What is even more important is the methodology of applying colorimetry to this problem, admirably expressed in several of the papers, notably that by G. Mackinney, University of California, "Color Measurement of Different Commodities," and the succeeding paper, "Color Dimensions of Interest to the Consumer," by A. Kramer, University of Maryland. Another of high caliber is O. J. Worthington's (Oregon State College) "Color Differences in the Quality Evaluation of Processed Fruits and Vegetables." Closer attention to these techniques might have obviated the extensive final discussion of the dangers (however real) in using filter photometers involving metameric color-matches. These three papers provide an adequate perspective of the British Method described, which seems to mistake the real need for color-control with the evident desire to implement it with visual—rather than photoelectric—colorimeters.

Perhaps the most promising advances in this field are those concerned with relations between color and the chemical compositions of the natural colorants, particularly as they are modified on storage. "Color Changes During Storage of Foods," by G. E. Livingston and C. R. Fellers, University of Massachusetts, and "The Effect of Heat Treatment of Some Plant Carotenoids," by Dr. Allan Joyce, Ministry of Food, Great Britain, are typical of this basic approach to the problem. It seems quite evident that substantial progress in relating color, however measured, to the quality of specific foods, cannot be made without a thorough understanding of the chemistry involved. Until this is achieved, valuable progress of the types cited will be made but it will be largely empirical. In passing, those versed in the chemistry of colorants, both natural and synthetic, must have raised eyebrows at the comment made earlier in this Symposium, that "there was no pure chemical compound brown in color."

S. R. Whipple's paper on "Color Inspection" is an excellent example of successful application research in the field of color instrumentation, featuring a truly comprehensive approach. The emphasis on selection and training of personnel to handle the colorimetric tasks involved reflects a high order of understanding of the problems involved. Future reports of sound progress by this and similar groups are anticipated.

GEORGE W. INGLE

[1] See also selected papers in "Symposium on Color of Transparent and Translucent Products," sponsored by ASTM Committee E-12, Washington, D. C., February 3, 1954, and available from ASTM Headquarters.

## Plastics Engineering Handbook

**Society of the Plastics Industry, Inc. Reinhold Publishing Corp., N. Y., 813 pp., $15.**

COMPLETELY rewritten and brought up to date, this expanded edition of the well-known SPI handbook is a compilation of engineering knowledge on design, materials, processing, testing, and specifications for plastics products. A very large number of individuals representing virtually all areas of plastics engineering cooperated under the able leadership of N. J. Rakas, General Chairman of the Engineering and Technical Committee of the SPI to compile this volume.

The five major sections covered in 20 chapters of the handbook are: I—Materials and Processes, II—Design, III—Finishing and Assembly, IV—Testing, and V—SPI Standards.

The section on testing makes liberal reference to ASTM Standards and the authors of this section include several active members of ASTM Committee D-20 on Plastics.

The book should serve a useful purpose both to plastics engineers for reference purposes and to others of the technical and engineering professions who are interested in the engineering aspects of this fast-growing new field.

• • •

## Abstracts of the Literature on Semiconducting and Luminescent Materials and Their Applications—1953 Issue

**The Electrochemical Society, Inc. John Wiley & Sons, Inc., New York; 169 pp. paperbound, $5.**

IN RECENT years a new electronics industry has started to emerge based on new discoveries of electronic processes in semiconducting and luminescent materials. Numerous papers have been published on the occurrence and nature of such processes in a host of solids including elements such as carbon, germanium, silicon, tin, selenium, tellurium, and phosphorus, etc.; inorganic compounds such as oxides, selenides, tellurides, antimonides, arsenides, phosphides, halides, and also some organic materials. Many practical applications have resulted including transistors, thermistors, electro-luminescent plates, Hall effect devices, and many others.

Because of rapid developments in this field and the difficulty of keeping up with papers in more than 50 periodicals throughout the world, The Electrochemical Society has made arrange-

(*Continued on page 77*)

# Errors in Deformation Measurements for Elevated-Temperature Tension Tests

## By John M. Thomas and John F. Carlson

*Tests illustrate magnitude of errors possible and also additional accuracy of one method of calculating the "effective" gage length for a test specimen with extensometer attachments beyond the reduced section.*

In the ASTM recommended practices for elevated-temperature tension tests, the short-time tests[1] recommend that "whenever feasible, the extensometer should be attached to the gage length of the test specimen, but it is permissible to attach the extensometer to the ends of the shackles projecting beyond the furnace." A note suggests that extensometers attached beyond the furnace be used only to determine yield strength, and not elastic modulus. For long-time tests,[2] it is recommended only that the accuracy of extension-measuring equipment be suitable for the purposes for which the materials under test are likely to be applied.

Errors that may be introduced in the selection of an "effective" gage length for tension or creep tests when the deformation measuring system is not attached directly to the reduced section of the test specimen are illustrated herein. Although the existence of these errors is common knowledge, it is believed that the magnitude which they may reach has not been fully appreciated. One problem illustrated is the change in the "effective" gage length within a series of tests or even with the progress of a single test.

A method for calculating the "effective" gage length from experimental creep data and specimen measurements has been shown to be reasonably accurate from low-temperature creep tests on 2S aluminum in which SR-4 strain gages could be used as standards.

There are many problems involved in high-temperature testing in attaching extension systems directly to the gage length. Mechanical connections are susceptible to loosening by differences in thermal expansion of the components and specimen, by relaxation in stressed bolts, and by reduction in cross-sectional areas. Oxidation limits the effective life of attachment fixtures, which must fit perfectly, while excessive specimen corrosion at the contact points limits the efficiency of the attachment fixtures. With longer tests and higher temperatures, the adverse effects of these factors become even greater. Furthermore, physical connections such as welding mar the specimen surface,

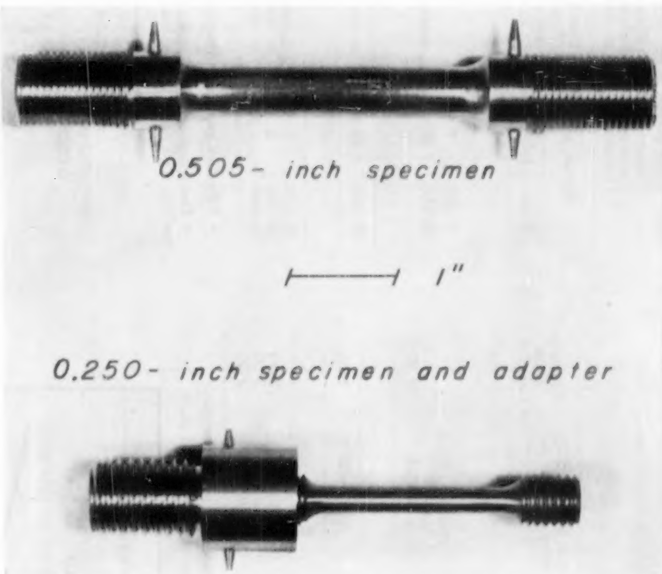



Fig. 1.—Specimen Sizes and Shapes.

**J. M. THOMAS, Manager, Research and Development, Hoskins Mfg. Co., has been in the field of high-temperature alloys and testing since 1946 with the Engineering Research Institute of the University of Michigan, and Scientific Laboratory of the Ford Motor Co.**

**J. F. CARLSON, Research Engineer, Metallurgy Department, Ford Motor Co., has been in the field of high-temperature alloys and testing since 1947 with the Engineering Research Institute, University of Michigan, and Allegheny-Ludlum Steel Corp.**

---

**NOTE.**—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Recommended Practice for Short-Time Elevated-Temperature Tension Tests of Metallic Materials (E 21 – 43), 1952 Book of ASTM Standards, Part 1, p. 1438.

[2] Recommended Practice for Conducting Long-Time High-Temperature Tension Tests of Metallic Materials (E 22 – 41), 1952 Book of ASTM Standards, Part 1, p. 1445.

TABLE I.—TENSION TEST AT 75 F ON 35 NI–18.5 CR ALLOY (0.505-IN. TEST SPECIMEN).

| | |
|---|---|
| Reduced section length | 2.16 in. |
| Fillet length (0.375-radius) | 0.28 in. |
| Shoulder-shoulder distance | 2.16 + (2) (0.28) = 2.72 in. |
| Shoulder-pin distance | 0.27 in. |
| Reduced section diameter | 0.506 in. |
| Shoulder diameter | 0.750 in. |

| Stress, psi | | Unit Deformation by SR-4 Strain Gages, in. per in. | | Deformation Measured by Extensometer System, in. | | Effective Gage Length[a] |
|---|---|---|---|---|---|---|
| Total | Increments | Total | Increments | Total | Increments | |
| ELASTIC DEFORMATION RANGE | | | | | | |
| 4 130 | 4 130 | 0 | ... | 0 | (Initial Readings) | |
| 25 850 | 21 720 | 0.000785 | 0.000785 | 0.002335 | 0.002335 | 2.97 |
| SMALL PLASTIC DEFORMATION | | | | | | |
| 31 100 | 5 250 | 0.001158 | 0.000373 | 0.003298 | 0.000963 | 2.58 |
| LARGE PLASTIC DEFORMATION | | | | | | |
| 35 400 | 4 300 | 0.004658 | 0.003500 | 0.010958 | 0.007660 | 2.19 |
| 38 500 | 3 100 | 0.009676 | 0.005018 | 0.021988 | 0.011030 | 2.20 |
| 40 600 | 2 100 | 0.014534 | 0.004858 | 0.032798 | 0.010810 | 2.22 |

[a] Effective gage length between extensometer pins = $\frac{\text{Deformation by extensometers}}{\text{Unit deformation by SR-4 gages}}$.

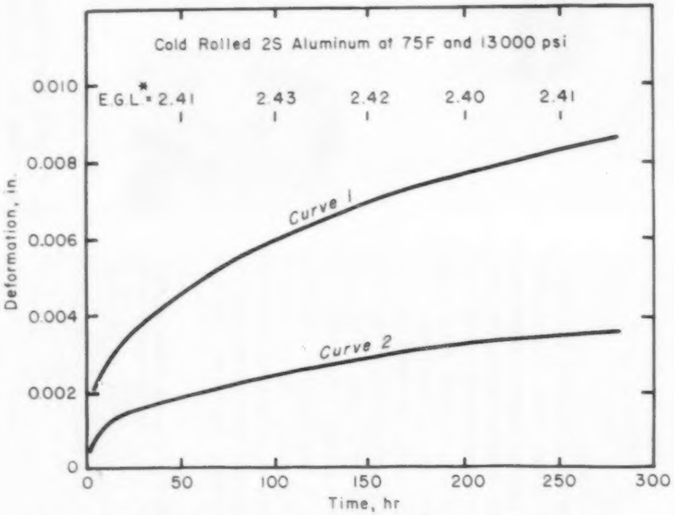



**Fig. 2.—Time-Elongation Curves for Creep Tests on 2S Aluminum.**

Curve 1.—Total deformation (in.) measured between shoulder pins by an optical extensometer system.
Curve 2.—Unit deformation (in. per in.) of the reduced section, measured by SR-4 strain gages.

* Effective gage length (E.G.L.) between shoulder pins = $\frac{\text{Total deformation}}{\text{Unit deformation}}$.

TABLE II.—TENSION TEST AT 75 F ON CARBON STEEL (0.250-IN. TEST SPECIMEN).

| | |
|---|---|
| Reduced section length | 1.60 in. |
| Fillet length (0.250-in. radius) | 0.15 in. |
| Distance between fillets at thread base | 1.60 + (2) (0.15) = 1.90 in. |
| Reduced section diameter | 0.250 in. |
| Diameter at base of threads | 0.400 in. |

| Stress, psi | | Unit Deformation by SR-4 Strain Gages, in. per in. | | Deformation Measured by Extensometer System, in. | | Effective Gage Length[a] |
|---|---|---|---|---|---|---|
| Total | Increments | Total | Increments | Total | Increments | |
| ELASTIC DEFORMATION RANGE | | | | | | |
| 7 410 | 7 410 | 0 | ... | 0 | (Initial Readings) | |
| 46 810 | 39 400 | 0.001326 | 0.001326 | 0.003525 | 0.003525 | 2.66 |
| SMALL PLASTIC DEFORMATION | | | | | | |
| 59 610 | 12 800 | 0.001790 | 0.000464 | 0.004716 | 0.001191 | 2.57 |
| LARGE PLASTIC DEFORMATION | | | | | | |
| 68 500 | 8 890 | 0.008163 | 0.006373 | 0.015306 | 0.010590 | 1.66 |
| 70 650 | 2 150 | 0.012763 | 0.004600 | 0.022916 | 0.007610 | 1.65 |
| 70 650[b] | 0 | 0.013763 | 0.001000 | 0.024566 | 0.001650 | 1.65 |

[a] Effective gage length between extensometer pins = $\frac{\text{Deformation by extensometers}}{\text{Unit deformation by SR-4 gages}}$.

[b] Deformation due to creep occurred at this high stress, accounting for the last deformation reading, with no additional loading.

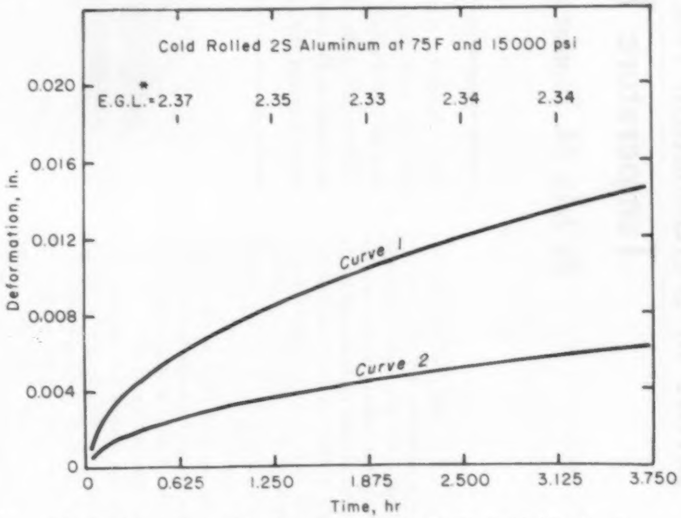



**Fig. 3.—Time-Elongation Curves for Creep Tests on 2S Aluminum.**

(See Fig. 2 for description of curves.)

* Effective gage length (E.G.L.) between shoulder pins = $\frac{\text{Total deformation}}{\text{Unit deformation}}$.

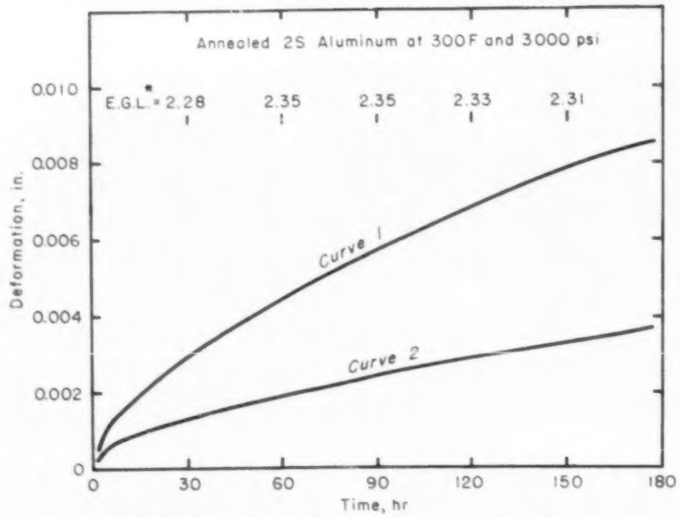



**Fig. 4.—Time-Elongation Curves for Creep Tests on 2S Aluminum.**

(See Fig. 2 for description of curves.)

* Effective gage length (E.G.L.) between shoulder pins $= \frac{\text{Total deformation}}{\text{Unit deformation}}$.

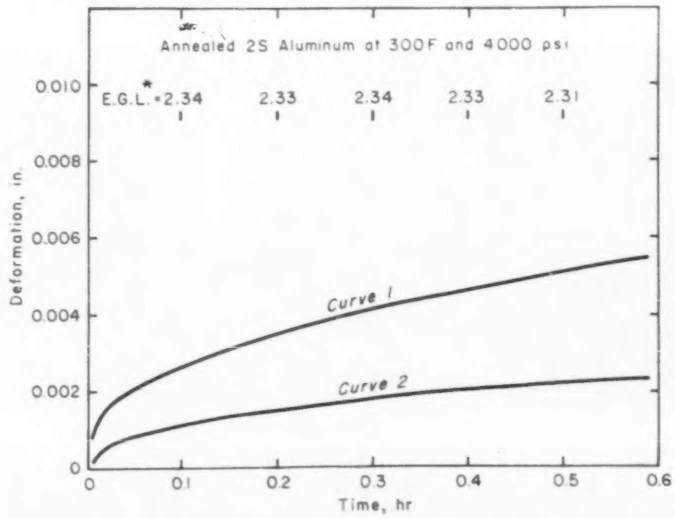



**Fig. 5.—Time-Elongation Curves for Creep Tests on 2S Aluminum.**

(See Fig. 2 for description of curves.)

* Effective gage length (E.G.L.) between shoulder pins $= \frac{\text{Total deformation}}{\text{Unit deformation}}$.

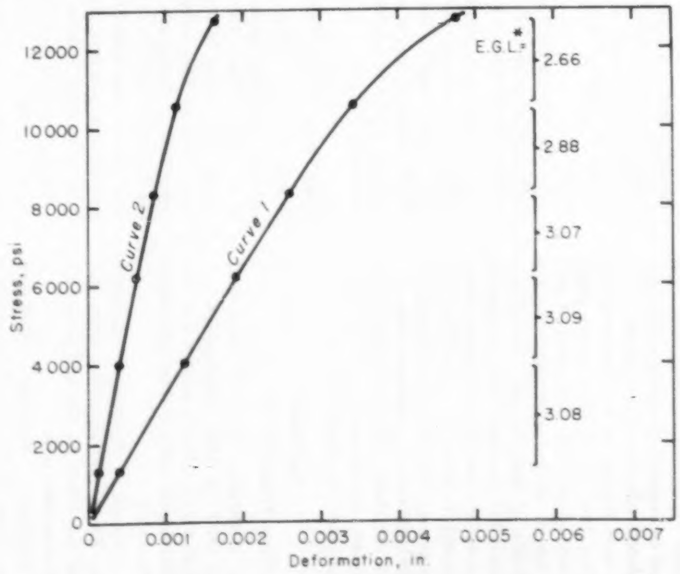



**Fig. 6.—Stress-Strain Loading Curve for the Creep Test on Cold Rolled 2S Aluminum at 75 F and 15,000 Psi.**

(See Fig. 2 for description of curves.)

* Effective gage length (E.G.L.) between shoulder pins $= \frac{\text{Total deformation}}{\text{Unit deformation}}$.

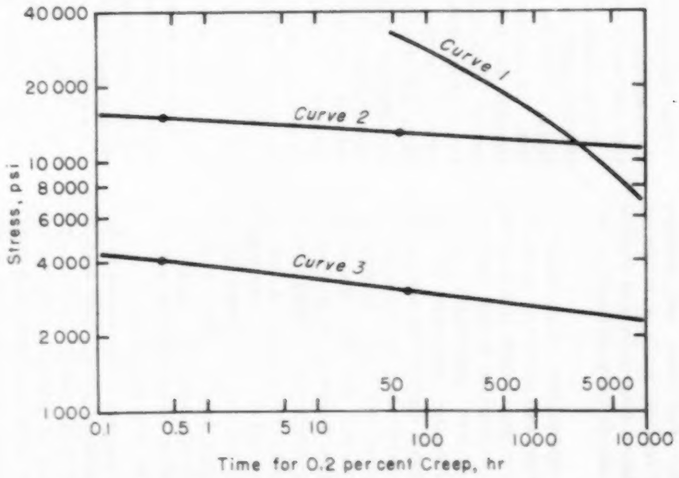



**Fig. 7.—Stress *versus* Time for 0.2 per cent Total Creep Deformation.**

Curve 1.—Based on data published by Mond Nickel Co. Ltd. for Nimonic 80 at 750 C.
Curve 2.—Cold rolled 2S Aluminum at 75 F.
Curve 3.—Annealed 2S Aluminum at 300 F.

which is contrary to ASTM requirements that the surface of the specimen be smooth. For these, and perhaps additional reasons, many investigators attach extensometer systems at various positions outside the gage length of the specimen.

If the deformation measurement is made between two points not on the reduced-section gage length, to reduce the measured deformation to unit deformation an "effective" gage length must be used. Deformation will occur not only in the reduced section but also in the fillets, shoulders, and any other part of the specimen and holder system included between the two measuring points. The deformation in some of these components may be insignificant, while in other components it may be appreciable, and the over-all effect must be properly evaluated to determine the effective gage length. With a given specimen design and extensometer system, the effect varies with the test material and the test conditions.

It is the purpose of this report to discuss a significant error which may be introduced in the use of extensometer systems not attached directly to the gage length of the specimen, and methods of compensating for that error. Prior to the experimental work described herein, a method was developed for calculating an effective gage length of test specimens from experimental tension and creep test results and specimen measurements.

These experiments were then conducted to evaluate the accuracy of the calculated effective gage length. All tests were limited to low temperatures to allow the use of SR-4 strain gages mounted directly on the reduced section length of the specimens for the standards of deformation. Aluminum was used for the creep tests because it will creep appreciably at temperatures low enough to allow the use of the SR-4 strain gages. By using the SR-4 gages as standards and an optical extensometer system attached to the shoulders of the specimens, an evaluation of the latter system could be obtained.

### Test Results

*Short-Time Tension Tests:*

The particular specimen sizes and shapes used for this investigation are shown in Fig. 1. It can be seen that the effective gage lengths of these specimens must include:

1. *0.505-in. Specimen.*—Reduced section, fillets, and shoulders from the edge of the fillets to the mid-points of the extensometer pins.

2. *0.250-in. Specimen.*—Reduced section, fillets, the threaded connection between the adaptor and specimen, and that part of the adaptor inside the pin locations.

The relative effects of the fillets and shoulders vary with the stages of a tension test, as shown in Tables I and II.

These results illustrate the change in effective gage length for specimens of this type with the progress of the tension test. In the early part of the test, through the elastic range, the reduced section, fillets, and shoulders deform in the exact ratios of their respective cross-sectional areas. The effects of the fillets and shoulders are large, making the effective gage length large. As soon as plastic deformation occurs in the reduced section, the relationship changes. Large plastic deformations occur in the reduced section from small increases in loading; whereas the shoulders and most of the fillet lengths have not yet yielded and deform only slightly due to elastic deformation.

Extension measurements in these two tension tests covered a range up to about 1.5 per cent total deformation. The effective gage length was at a maximum and remained constant throughout the elastic range. As soon as plastic deformation occurred in the reduced section the effective gage length decreased rapidly.

When a total deformation of about 0.5 per cent had been reached, the factor for the effective gage length leveled off at a value 25 to 35 per cent less than the factor found in the elastic range.

This illustrates two dangers in the determination of an effective gage length for tension tests on specimens to which the deformation measuring system is attached outside the reduced section:

1. Effective gage lengths determined in the elastic range will not be accurate for the plastic range, and *vice versa*.

2. In the early stages of plastic deformation, such as the 0.2 per cent offset yield region, the effective gage length changes rapidly so that no single over-all factor is accurate over the entire range.

*Long-Time Tension Tests (Creep Tests):*

Just as the effective gage length changes with the stages of deformation in a tension test, the effective gage length in a creep test depends on the conditions of the creep test. If the creep rate is extremely stress sensitive the deformation in the fillets and shoulders will be less significant than for a material-temperature combination that is not particularly stress sensitive.

Several creep tests were conducted on 2S aluminum at 75 and 300 F. At these temperatures, SR-4 strain gages could be used as standards for measuring unit deformation, which in turn could be used to calculate the effective gage length between any two points to which extensometer bars were attached. The same type of 0.505-in. specimen shown in Fig. 1 was used for these tests. Figures 2 to 5 show the time-elongation curves for these creep tests, and Fig. 6 shows the stress-strain loading curve for one of the creep tests.

Curve 2 in Figs. 2 to 6 represents the true unit deformation in inches per inch as measured with SR-4 strain gages. Curve 1 is the deformation in inches as measured with an optical extensometer system between two pins in the shoulders of 0.505-in. specimens of the type shown in Fig. 1. The ratio of the deformation between the pins to the unit deformation is the effective gage length between the pins. The effective gage length values are also shown at intervals on the graphs.

Figure 7 is a logarithmic plot of stress *versus* time for 0.2 per cent creep deformation taken from the SR-4 curves of Figs. 2 to 5. From the curve given in Fig. 7 an effective gage length may be calculated for the specimen. Such a sample calculation is shown in Table III for the 75 F–15,000 psi test, while Table IV gives a comparison of calculated effective gage lengths with experimental values.

In Table III the fillet length was broken down into increments, the mean diameter for each increment determined graphically, and the increment stress calculated. The time required for the increment stress to produce a predetermined unit of creep was then evaluated using Fig. 7 (0.2 per cent creep was arbitrarily selected for the plot in Fig. 7 and has been used in these calculations). The ratio of the times for the stresses in the reduced section and the fillet increment to cause the predetermined unit of creep, multiplied by the length of the increment, determines the *effective* length of the increment. This assumes steady state creep in all parts of the specimen, which is an approximation susceptible to errors when first stage creep is large in magnitude. Any effect of unusual deformation due to stress concentrations was also ignored in the calculations. The summation of the effective lengths of all the components, including the increments of the curved fillets, is the effective gage length.

In these tests on aluminum only part of the fillets and none of the shoulders influenced the effective gage length because of the deformation characteristics of the material at the test temperatures. This is definitely not the situation for some other materials under some conditions of creep testing with the same specimen dimensions. The 0.750-in. shoulders for these 0.505-in. specimens

do figure into the effective gage length with steeper deformation curves than those shown in Fig. 7, curves 2 and 3.

For example, curve 1 in Fig. 7 has been drawn from published creep data for Nimonic 80 alloy at 750 C. From this curve, a calculation was made for the effective gage length of a fictitious specimen, identical in dimensions to the aluminum specimen tested at 75 F and 15,000 psi. This calculation is tabulated in Table III. The calculated effective gage length for these conditions was 2.53, or 9 per cent higher than the 2.32 shown for the aluminum test, assuming identical specimen dimensions.

Differences of this magnitude, or even greater, can exist for a given alloy and specimen size over a temperature range of testing, simply due to a steeper stress-creep rate curve with increasing temperature. Nimonic 80 has a steep stress-creep rate curve, and the data have been used to illustrate the point that errors in effective gage length are dependent upon the slope of this curve.

It is also apparent from Table IV that one average effective gage length for all of these specimens would have been as accurate as the calculated values. This is true for a given material over a limited range of test conditions. However, for a different material or widely different set of test conditions, this will not hold true, even though the specimen dimensions are identical.

The method of calculation of the effective gage length of creep test specimens presented herein is only one approach to the problem. There are, of course, many other possible approaches to the problem, but the important thing is that the existence of the problem be recognized and allowances made for it.

## Summary

No simple method would make the effective gage length calculation precise, but errors can be minimized. The method of calculation used in this case, although only a close approximation, appears to be reasonably accurate on the basis of the experimental results shown. It is essential that the degree of error which is possible be realized and some proven method be used which will correctly allow for deformations within the points of measurement but outside the reduced section of the test specimen.

TABLE III.—CALCULATED EFFECTIVE GAGE LENGTHS OF 0.505-IN. DIAMETER CREEP TEST SPECIMENS.

| Diameter, in. | $\frac{d^2}{0.506^2}$ | Stress, psi | $L$ Length, in. | $t^a$ Time for 0.2 per cent Creep, hr | $L\frac{t_0}{t}{}^b$ Effective Length in. |
|---|---|---|---|---|---|
| COLD-ROLLED 2S-ALUMINUM AT 75 F AND 15 000 PSI | | | | | |
| *Reduced Section* | | | | | |
| 0.506 | 1.000 | 15 000 | 2.23 | 0.4 | 2.230 |
| *Fillets* | | | | | |
| 0.507 | 1.005 | 14 900 | 0.050 | 0.5 | 0.040 |
| 0.509 | 1.012 | 14 800 | 0.050 | 0.6 | 0.033 |
| 0.515 | 1.035 | 14 450 | 0.050 | 1.5 | 0.013 |
| 0.526 | 1.080 | 13 880 | 0.050 | 5.0 | 0.004 |
| 0.539 | 1.135 | 13 200 | 0.050 | 30.0 | 0.001 |
| 0.556 | 1.208 | 12 400 | 0.050 | 250 | 0.001 |
| 0.577 | 1.300 | 11 520 | 0.050 | 3000 | <0.001 |
| | | | Total Effective Gage Length...... | | 2.32 |
| THEORETICAL TEST ON NIMONIC 80 AT 750 C AND 30 000 PSI (BASED ON MOND NICKEL CO. LTD. PUBLISHED DATA) | | | | | |
| *Reduced Section* | | | | | |
| 0.506 | 1.000 | 30 000 | 2.23 | 80 | 2.230 |
| *Fillets:* | | | | | |
| 0.507 | 1.005 | 29 850 | 0.050 | 83 | 0.048 |
| 0.509 | 1.012 | 29 650 | 0.050 | 87 | 0.046 |
| 0.515 | 1.035 | 29 000 | 0.050 | 90 | 0.044 |
| 0.526 | 1.080 | 27 800 | 0.050 | 105 | 0.038 |
| 0.539 | 1.135 | 26 450 | 0.050 | 130 | 0.031 |
| 0.556 | 1.208 | 24 800 | 0.050 | 180 | 0.022 |
| 0.577 | 1.300 | 23 100 | 0.050 | 240 | 0.017 |
| 0.605 | 1.430 | 21 000 | 0.050 | 360 | 0.011 |
| 0.630 | 1.550 | 19 350 | 0.050 | 480 | 0.008 |
| 0.668 | 1.745 | 17 200 | 0.050 | 750 | 0.005 |
| 0.714 | 1.990 | 15 100 | 0.066 | 1200 | 0.004 |
| *Shoulders* | | | | | |
| 0.750 | 2.200 | 13 650 | 0.500 | 1700 | 0.024 |
| | | | Total Effective Gage Length.... | | 2.53 |

[a] From Fig. 7.

[b] $L\frac{t_0}{t} = \text{(segment length)}\left(\frac{\text{Time for 0.2 per cent creep for the reduced section}}{\text{Time for 0.2 per cent creep for the segment}}\right)$.

TABLE IV.—COMPARISON OF EFFECTIVE GAGE LENGTHS CALCULATED ON THE BASIS OF TOTAL EXTENSION DATA AND EFFECTIVE GAGE LENGTHS EXPERIMENTALLY DETERMINED ON 0.505-IN. DIAMETER 2S-ALUMINUM CREEP TEST SPECIMENS.

| Test Temperature, deg Fahr | Test Stress, psi | Effective Gage Length, in. Calculated | Effective Gage Length, in. Experimentally Determined | Error in Calculated Value, per cent |
|---|---|---|---|---|
| COLD-ROLLED 2S-ALUMINUM | | | | |
| 75 | 15 000 | 2.32 | 2.37[a] | −2.1[a] |
| 75 | 13 000 | 2.34 | 2.40 | −2.5 |
| ANNEALED 2S-ALUMINUM | | | | |
| 300 | 4 000 | 2.35 | 2.30 | +2.1 |
| 300 | 3 000 | 2.36 | 2.37 | −0.4 |

[a] If the effective gage length for the 75 F, 15,000 psi test had been experimentally determined by a tension test in the elastic range, the value shown in Fig. 6, which is the loading curve for this test, would have been obtained. This elastic-range value of 3.07 to 3.09 then would have been in error by 30 per cent from the true creep test value of 2.37 shown above.

# Fatigue Testing of Nonrigid Plastics

By R. H. Carey

*Fatigue life is shown to be primarily a function of applied stress.*

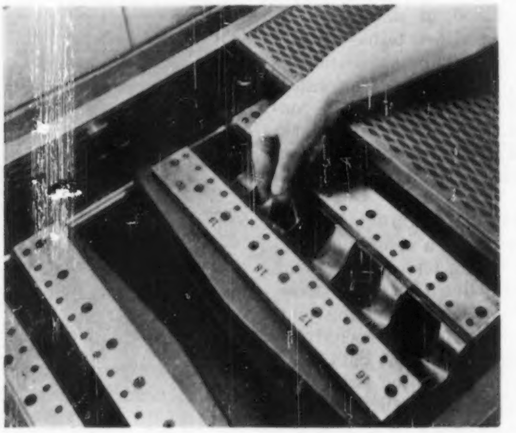


Fig. 1.—Duggan and Fligor Fold Flex Test Apparatus.

THE word "fatigue" has often been used to describe any failures which may occur with time, including such failures as those resulting from cold flow, compression set, and creep. In this paper, the word "fatigue" is used to describe the growth of a crack caused by repeated stressing or straining. The ultimate in fatigue testing depends upon the proper control and evaluation of the stress, stiffness, strain, and temperature. With most materials such control is not very difficult, but with plastic materials this control is not only difficult but becomes very important.

Ten years ago Duggan and Fligor[1] published one of the first papers on the fatigue testing of flexible plastic sheeting. Although this work was useful in developing several successful fatigue-resistant compounds, it did not give a complete answer to the problem. In continuation of the work, several unsuccessful attempts were made to modify the De Mattia[2] machine. It was finally abandoned in favor of a Ross Flexing Machine[3] which with a few minor modifications gave good results. The data from the Ross Flexing Machine were found to be particularly useful if properly interpreted by complementary use of the Clash-Berg Torsion Tester.[4] By combining the data obtained from these two machines it is possible to obtain the fatigue life of a given resin-plasticizer system and the data so obtained are independent of the concentration of the plasticizer. The data obtained from these two tests are combined in such a way that the log of the fatigue life is plotted as a function of the applied stress. This *S-N* diagram method of analysis is commonly used in engineering problems.

### Apparatus

The fold flex test of Duggan and Fligor is illustrated in Fig. 1. The material to be tested was folded to make a specimen as shown and was held by grips in the stationary and oscillating crossheads. The end point of the test was defined as the beginning of a crack in the folded crease. This definition was very subjective, and the failure point was often difficult to detect. Because of this feature, the test was modified to produce a repeated elongation on a tension specimen. Although this repeated elongation was a good attempt to control strain, it was only partially satisfactory. Creep was very troublesome and the strain was found to be highly localized. This resulted in considerable overheating and a consequent reduction in stiffness. Pronounced differences between hot, soft regions and cold, stiff regions were easily observed. Failure was defined as complete rupture of the specimen. Although the data were not very reproducible, it was observed that log cycles to failure were roughly linear with per cent elongation.

The De Mattia tester was finally abandoned and a Ross Flexing Machine adopted (Fig. 2). This machine is essentially of the constant strain type and, for materials having little creep, probably achieves this constant strain. With plastics, however, the creep was so great that the strain level was uncertain. After a few minor modifications, consisting of a system of wires and pulleys, the machine proved to be very useful. The test specimen used for plastics is shown in Fig. 3. Each specimen was

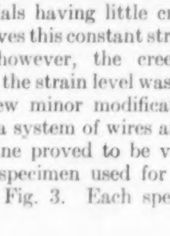
**NOTE.**—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] F. W. Duggan and K. K. Fligor, "Fatigue Resistance of Flexible Plastic Sheetings," *Industrial and Engineering Chemistry*, Vol. 35, February, 1943, pp. 172–176.

[2] Tentative Method of Test for Resistance of Vulcanized Rubber or Synthetic Elastomers to Crack Growth (D 813 – 52 T), 1952 Book of ASTM Standards, Part 6, p. 350.

[3] Tentative Method of Test for Resistance of Vulcanized Rubber or Synthetic Elastomers to Cut Growth by the Use of the Ross Flexing Machine (D 1052 – 52 T), 1952 Book of ASTM Standards, Part 6, p. 439.

[4] R. F. Clash, Jr., and R. M. Berg, "Stiffness and Brittleness Properties of Nonrigid Vinyl Chloride-Acetate Resin Compounds," Symposium on Plastics, Am. Soc. Testing Mats., p. 54 (1944). (Issued as separate publication *ASTM STP No. 59*).



**R. H. CAREY, Group Leader in Mechanics and Rheology, Development Laboratories, Bakelite Co., Bound Brook, N. J., has since 1944 been working on mechanical testing and processing problems with Bakelite.**

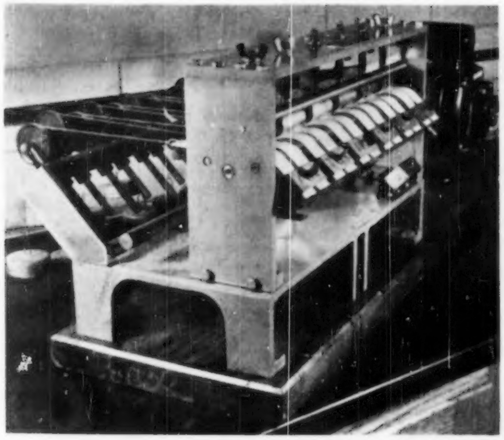


Fig. 2.—Ross Flexing Machine.

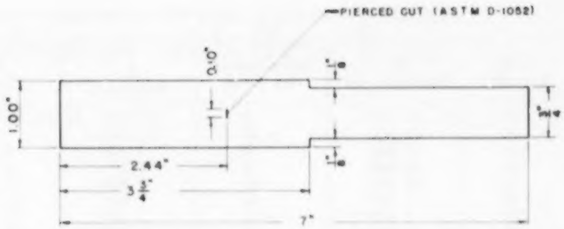



Fig. 3.—Test Specimen Used for Plastics in the Ross Flexing Machine.

pierced with a standard, chisel-pointed tool (0.10 in. wide) at a point which was directly over the mandrel when installed in the testing machine. The one-pound weights and wires were attached to the free end of the specimen with a staple. One end of the specimen was clamped to a holder arm and the other end placed between two rollers which allowed a free bending movement of the specimen over a $\frac{3}{8}$-in. diameter mandrel. The holder arm operated at a frequency of 100 cycles per min, oscillating between a horizontal position and a vertically downward position. The weight, pulleys, and rollers kept the specimen taut and assured that the bent specimen followed the radius of the mandrel. This is particularly important when testing relatively thin specimens (0.070 in.) and materials which have a tendency to creep. The test was completed when the specimen fractured and the weights dropped. The test specimens averaged 0.070 in. in thickness, but one experiment designed to measure the effect of thickness showed good normalization of the data in a range between 0.045 and 0.090 in. The exciting and natural frequencies were quite different and no "bouncing" occurred.

### Analysis of Fatigue Stress

Figure 4 is a geometrical analysis of the stress and strain in a bent specimen neglecting the small axial load. The surface fiber strain, $\epsilon$, is the elongation of the outer fiber, $e$, divided by the length of the element, $l$.

$$\epsilon = e/l$$

From the geometry of similar circular sectors,

$$2e/t = \frac{l}{R}$$

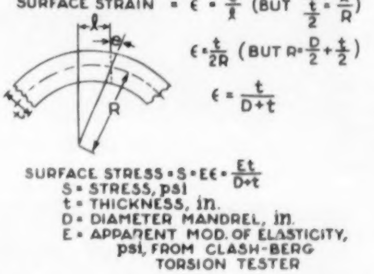



Fig. 4.—Analysis of Stress and Strain in a Bent Specimen.

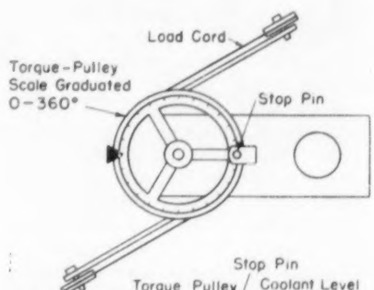



Fig. 5.—Bakelite Torsion Tester.

The radius of curvature, $R$, however, is equal to the radius of the mandrel ($\frac{3}{16}$ in.) plus half the thickness of the specimen. The surface strain may then be expressed in terms of the diameter of the mandrel and the thickness of the specimen as follows:

$$\epsilon = \frac{t}{D + t} \quad (1)$$

The surface stress is equal to the apparent modulus of elasticity, $E$, multiplied by the surface strain. Therefore,

$$S = \frac{Et}{D + t} \quad (2)$$

Equation 2 is used to reduce all data to values of repeated stress provided the thickness, $t$, diameter of mandrel, $D$, and apparent modulus of elasticity, $E$, are known. This latter quantity may be conveniently determined at any temperature by means of the Clash-Berg Torsion Tester. Figure 5 is a schematic drawing of this tester which is described in detail in ASTM Method D 1043.[5] Briefly, the Clash-Berg Stiffness Tester consists of a controlled temperature bath containing the specimen and means for applying a twisting torque and measuring the resulting angle of twist. From the applied torque and angle of twist, it is possible to compute a shearing modulus of elasticity which, by means of the proper formulas, may be converted to stiffness or apparent modulus of elasticity.[5]

### Summary of Data

The fatigue characteristics of four different resin-plasticizer systems have been studied with these techniques. Vinyl chloride-acetate resin, VYNW, was compounded at several concentrations with the following plasticizers:

1. "Flexol" Plasticizer DOP (di-2-ethylhexyl phthalate)

[5] Standard Method of Test for Stiffness Properties of Nonrigid Plastics as a Function of Temperature by Means of a Torsional Test (D 1043 – 51), 1952 Book of ASTM Standards, Part 6, p. 643.

TABLE I.—FATIGUE LIFE OF VYNW-DOP COMPOUNDS.

| DOP, per cent | E, Modulus, psi | T, Temperature, deg Cent | S, Stress, psi | N, Cycles | Coefficient of Variation, per cent |
|---|---|---|---|---|---|
| 25.... | 71 000 | 0 | 12 900 | 480 | 3 |
| 35.... | 62 000 | −20 | 11 300 | 700 | 6 |
| 28.... | 37 000 | 0 | 6 000 | 2 080 | 9 |
| 30.... | 22 000 | 0 | 3 900 | 4 440 | 14 |
| 40.... | 16 000 | −20 | 2 900 | 8 500 | 8 |
| 45.... | 9 000 | −25 | 1 600 | 23 000 | 9 |
| 25.... | 6 000 | +25 | 1 100 | 27 000 | 3 |
| 35.... | 5 000 | 0 | 900 | 28 000 | 7 |

TABLE II.—FATIGUE LIFE OF VYNW-R-1 COMPOUNDS (AT 0 C).

| R-1, per cent | E, Modulus, psi | S, Stress, psi | N, Cycles | Coefficient of Variation, per cent |
|---|---|---|---|---|
| 41.. | 90 000 | 15 700 | 230 | 31 |
| 43.. | 63 000 | 11 200 | 620 | 14 |
| 43.. | 56 000 | 9 900 | 620 | 9 |
| 45.. | 46 000 | 8 000 | 970 | 8 |
| 45.. | 37 000 | 6 200 | 1 100 | 9 |
| 45.. | 25 000 | 4 600 | 1 500 | 5 |
| 47.. | 25 000 | 4 600 | 1 400 | 9 |
| 47.. | 22 000 | 3 700 | 1 580 | 5 |

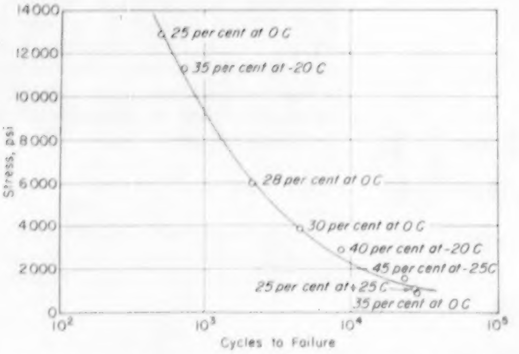



**Fig. 6.—Fatigue Life of VYNW-DOP System (Plot of Data from Table I).**

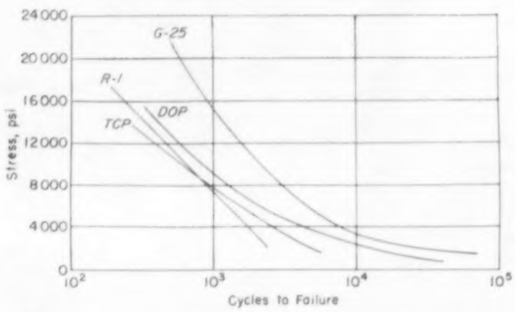



**Fig. 7.—Fatigue Life of Different Resin-Plasticizer Systems.**

2. "Paraplex" G-25 (sebacic acid polyester)
3. "Flexol" Plasticizer R-1 (aliphatic polyester)
4. TCP (tricresyl phosphate)

The detailed test results for the VYNW-DOP system and the VYNW-R-1 system are given in Tables I and II. These data are representative of the kind of information that can be obtained with these techniques and also give some measure of the reproducibility that can be expected. Six specimens of each material were tested and the arithmetic mean of the observed number of cycles computed. The test reproducibility was assessed by the "coefficient of variation," that is, the standard deviation of the observed values divided by the arithmetic mean. The data of Table I are plotted in Fig. 6, which is similar to the customary stress-number of cycles diagram used in engineering practices. This curve (Fig. 6) is a fatigue diagram of a VYNW-DOP resin-plasticizer system. The fatigue life is shown to be a function of the repeated stress whether that stress is induced by plasticizer concentration or temperature. Apparently, stress is the governing factor in fatigue and not strain since the geometrical configuration of the bent specimen was the same for all tests. The plasticizer concentration and test temperature are given for each point.

In Table II, the fatigue life is again shown to be a function of the repeated stress. Several compounds of the same plasticizer concentration were separately mixed and pressed. Although these materials were of the same composition, the variables of processing produced differences in stiffness which resulted in a difference in fatigue life. In other words, there is better agreement between stress and cycles to failure than between plasticizer concentration and cycles to failure.

Figure 7 summarizes all of the data on the four resin-plasticizer systems independent of plasticizer concentration and temperature. A VYNW-G-25 system is apparently superior to the other three systems. Fine distinctions in fatigue life are not possible, however, without a more thorough statistical analysis. In any practical problem, of course, the amount of plasticizer is still very important. This method of analysis, although it provides a better understanding of fatigue, does not solve many of the other problems associated with the kind of plasticizer used.

## Conclusions

It is believed that the data and method of analysis shown here permit a more thorough understanding of the nature of fatigue in elastomers. The data show that fatigue life in nonrigid plastics is primarily a function of the applied stress. In other words, the data of Fig. 7 show that a fivefold increase in stress produces a tenfold decrease in number of cycles to failure. In this test, as in most applications, the material undergoes a constant, repeated strain. Under such conditions of flexing, therefore, the stress can only be altered by reducing the stiffness of the material. The important point is that fatigue data obtained without regard for stiffness are not only meaningless, but can be very misleading.

The testing machine, of course, can be used to study a number of simple practical problems such as comparing the fatigue life of two given materials. It is erroneous, however, to compare the fatigue life of different materials except on the basis of equal stiffness and thickness.

# Measuring Traffic Paint Abrasion with Beta Rays

## By B. W. Pocock

A TRAFFIC paint must possess unusual durability characteristics. It must adhere to the underlying pavement surface resisting all factors operating to reduce the thickness of the dried paint film. Such factors include chemical attack by salts used for snow and ice removal, solvent action by oils and gasoline, and direct physical abrasion by road-scraping machinery, by dust, and by the movement of normal traffic.

In addition, pavement paints must resist the expansion and contraction differentials attending repetitive freezing-and-thawing cycles. They must be able to accept and hold glass beads. Daily and seasonal temperature fluctuations must be without significant effect, as must be true also of the bleaching action of ultraviolet light on the vehicle employed. The paint must resist leaching by rain water and bleeding of bituminous materials in and on the highway. It must be capable of being sprayed. In view of these exacting requirements it is not surprising that a satisfactory laboratory test has never been devised for predicting the durability of traffic paint under field conditions.

For several years the Michigan State Highway Department's testing and research division has been concerned with the growing need for a method of correlating laboratory behavior with field performance of traffic paints. Early efforts centered around the use of a paint wear machine, designed for studies of abrasion resistance. In this machine, shown in Fig. 1, a flat ring of dense portland-cement mortar is supported in such a manner that it is free to rotate on a turntable. The ring is made of six similar segments clamped together in the form of an annulus.

Paint stripes are applied by doctor blade on the mortar ring. After a suitable drying and curing period has elapsed, there is set in motion a vertical drive wheel that rests on top of the ring on one side of the machine, making the ring rotate about 33 rpm and pass over all paint stripes. Simultaneously, a similar vertical wheel on the other side of the machine rests on the ring, and all paint stripes pass beneath it. This second wheel is braked by a 10-lb weight acting on a prony brake. Originally both drive wheel and brake wheel were capped by flat eraser stock abrasive tires.

***The beta ray backscatter gage can determine dry film thicknesses to the nearest tenth of a mil.***

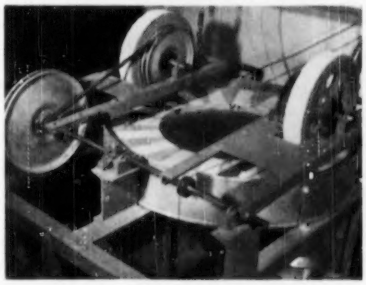


**Fig. 1.—Paint Wear Machine. Oblique View.**

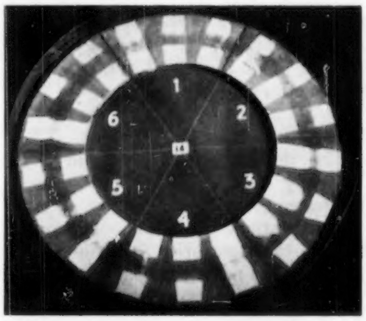



**Fig. 2.—Wheel Track Areas Passing Through Paint Stripes on Mortar Ring of Paint Wear Machine.**

Since the paint stripes were 2 in. wide and the wheels under which they passed were also 2 in. in width, any abrasion resulted in a square 2 in. on each side being worn into the paint film to an unknown depth (Fig. 2). A 2-in. square grid was etched on a glass plate with lines $\frac{1}{4}$ in. apart, thus making 64 small squares. After a given number of revolutions of the mortar ring, this grid was placed over the worn square in each paint stripe and the number of small squares that showed complete wear through to the mortar base was counted. The number of small squares for each paint showing complete wear was plotted against the number of revolutions of the mortar ring, and in this way curves of abrasion resistance were obtained.

Some correlation with field behavior was observed in these early tests. The results, however, were inconsistent, and it was recognized that the test would have to be greatly improved before it would be of value. Accordingly, provision was made for wet cycles as well as for dry cycles, a water spray being turned on during the wet cycles. Drive and brake wheels were counterbalanced so that pressure over tire contact areas corresponded with that in the case of conventional passenger cars. Paints were applied by doctor blade and all paints had the same wet film setting. The same mortar ring was cleaned and used over again. Different paint curing methods were studied, including the use of oven heat and infrared radiation. The eraser stock tires were replaced by abrasive-impregnated tires. The prony brake was removed from the drag wheel, allowing the latter to run freely. Nothing resulted in an acceptable degree of conformity with field performance, however. It was believed that the method of application of the paint and the method of appraisal might both be at fault.

#### Appraisal by Radioactivity

The isotope section of the research laboratory took up the task of develop-

**B. W. POCOCK, head of the Isotopes Section of the Michigan State Highway Department Research Laboratory, is a Registered Professional Engineer in the State of Michigan and chairman of Subcommittee IV on Radioactive Gages, of ASTM Committee E-10 on Radioactive Isotopes.**

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

ing a method based on radioactivity for measuring the thicknesses of dry paint coatings. Such a technique, if successful, would make it possible to follow actual changes in thickness of paint stripes during tests without the necessity of waiting until the supporting base began to show through. Because of the nonmagnetic nature of concrete and the various types of blacktop pavements and the desirability of developing a method which could be used in the field as well as in the laboratory, it was felt that a procedure based upon radioactivity would have to be employed.

Three such procedures were available for consideration. The method of tracer technology would involve incorporating radioactivity into the paint (labeling) and measuring decrease in activity as the paint wore away. As it would also introduce a health hazard from the standpoint of radioactive waste and dust disposal, it was ruled out at the start. A second method would make use of activity applied on the pavement surface, measurements being taken of the increase in activity as the overlying paint wore away. Here again, considerations of safety rendered the method undesirable. The procedure of beta ray backscatter, however, involves no health hazard; a sealed source of radioactivity is employed, and the thicknesses of materials are determined by measuring the rates at which the materials bounce beta particles back into the counter tube. It was decided therefore to adopt the backscatter method in this investigation.

As reported by Zumwalt (**1**)[1] and by Clarke, Carlin, and Barbour (**2**), materials react in three ways when

[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

**Fig. 3.—Beta Gage Completely Assembled.**

bombarded by beta rays. If the materials are sufficiently thin, they will transmit a portion of the radiation. No matter what the thickness, they will always absorb a portion. Lastly, they reflect a portion, and it is this reflected portion which is utilized in the beta ray backscatter gage.

*Michigan's Beta Gage:*

The design of the Michigan State Highway Department's beta ray backscatter gage is shown in Figs. 3 to 6. The strontium 90 source of approximately 10 microcuries (half-life 25 yr) is sealed in a brass holder in such a way that its beta radiation can escape only in a generally downward direction. Immediately above the source holder is the open window of a conventional end-window counter tube. Ideally no radiation can enter the tube because of the mass of the brass holder, which acts as a shield. Actually, a "background" averaging 1.64 counts per sec is observed when the assembled gage is suspended in open air several feet above the floor. This background includes normal atmospheric radiation originating in thoron and radon disintegration, cosmic radiation, and beta rays from the 90 source which escape the shielding, are reflected by the plastic tubing strontium or both. These latter may produce X-rays (bremsstrahlung) that contribute to the background.

When the gage is placed on the surface of a given material the counting rate rises considerably. Depending upon the nature of the material, the rate may be 20, 30, 40, or higher counts per sec. It reaches 169.50 counts per sec when placed on lead, which possesses outstanding capacity to reflect beta rays. Yet before one can state categorically that 169.50 counts per sec is characteristic of lead with a particular geometry, source energy, source strength, and counter assembly, one must be certain that the lead is of at least "infinite" thickness. By infinite thickness is meant that thickness which is infinite for beta ray backscatter counting. With materials of less than infinite thickness, the beta ray backscatter counting rate is a function of the thickness; beyond infinite thickness the rate becomes constant for any thickness. Friedlander and Kennedy (**3**) report that the infinite thickness of any material for beta ray backscatter is about one fifth of the total range of the beta particles in that material. The range in turn depends upon the energy

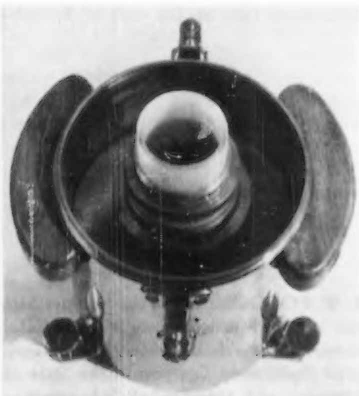


**Fig. 4.—Beta Gage Showing View with Exterior Cover Removed.**

**Fig. 5.—Beta Gage Showing Source Holder, Plastic Cylinders and Brass Friction Rings Comprising Interior. Assembled.**

**Fig. 6.—Beta Gage Showing Source Holder, Plastic Cylinders and Brass Friction Rings Comprising Interior. Unassembled.**

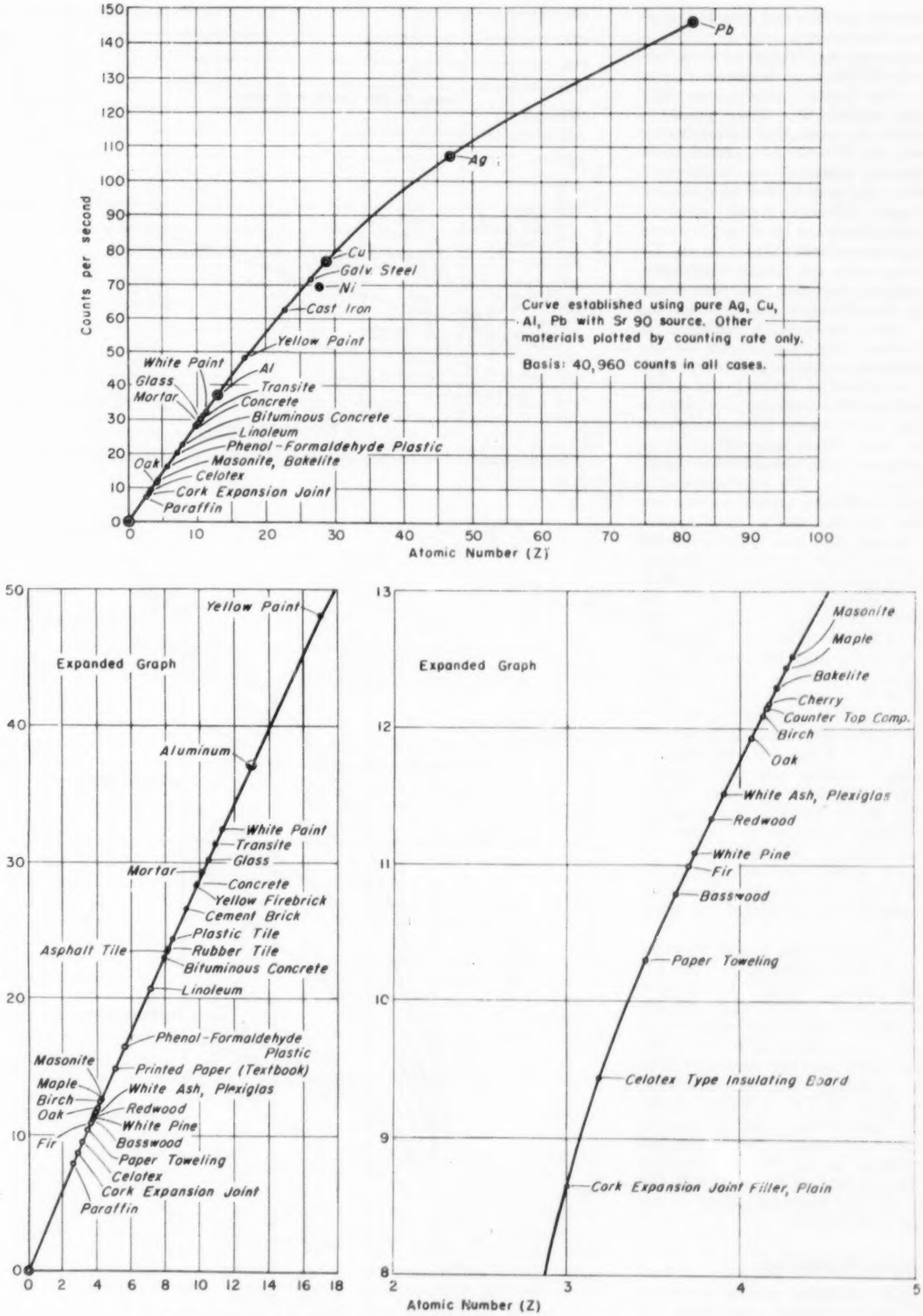



Fig. 7.—Backscatter Counting Rate as a Function of Effective Atomic Number for Infinite Thickness of Materials Shown.

of the beta particles and upon the properties of the material.

In general, the rate at which a material will reflect or backscatter beta rays is a function of the material's atomic number, $Z$. More precisely, Zumwalt (**4**) reports that the rate varies directly as $Z^{0.7}$ to $Z^{0.8}$ Since most engineering materials are mixtures of chemical compounds, one may employ the term "effective atomic number" as a sort of average for all of the atoms in a given material. Fig. 7 shows the counting rates for infinite thicknesses of various materials as determined using the Michigan gage. These are net rates; background radiation is subtracted. The rates shown for the elements aluminum, copper, silver, and lead were used to establish the curve. Points for other materials shown were plotted on the curve by counting rate only; their effective atomic numbers are obtained from the indicated points on the abscissa. The significance of a material's effective atomic number lies in the fact that this is an independent variable and is a characteristic of the material itself, whereas the counting rate is a dependent variable and is fixed not only by the material but also by the properties of the gage. Analysis of the data on the curve indicates that with the Michigan gage the counting rate varies as $Z^{1.037}$ between cork and aluminum, as $Z^{1.115}$ between aluminum and copper, as $Z^{1.447}$ between copper and silver, and as $Z^{1.775}$ between silver and lead. Figure 8 shows the relationship between counting rate and specific gravity for the same materials. Noteworthy is the tendency for common engineering materials to cluster in "family groups" on these curves, a tendency which could undoubtedly be made to form the basis for an analytical or identification procedure for some materials.

There is no health hazard involved in using the Michigan gage. The accepted Atomic Energy Commission tolerance level is 300 milliroentgens per week for whole body radiation by gamma rays (equivalent to 300 millireps per week from beta sources). Most workers multiply this tolerance level by a factor of 5 for radiation of the hands. All radiation from the gage is stopped by the walls. That coming out the bottom is only 10 milliroentgens per hr measured at the bottom of the gage, and this decreases rapidly as the square of the distance.

*Principle of the Beta Gage:*

For a stipulated source, geometry and counter assembly, the beta ray backscatter counting rate at infinite thickness is a characteristic property

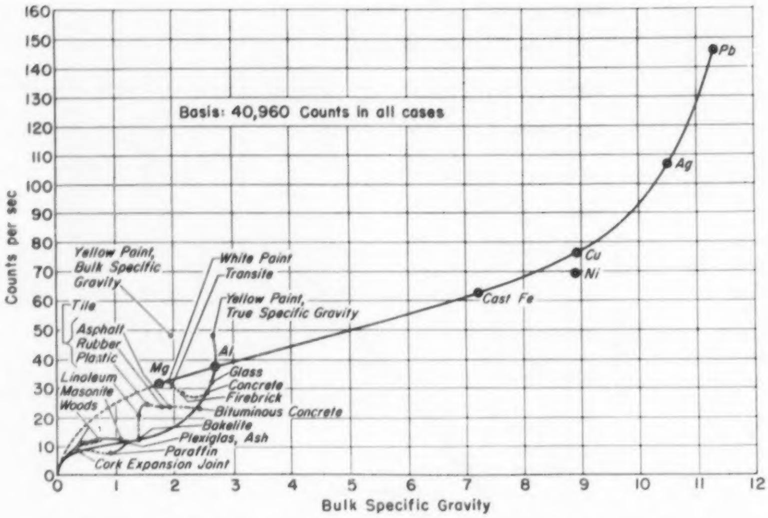



**Fig. 8.—Various Engineering Materials, Counting Rate *versus* Specific Gravity.**

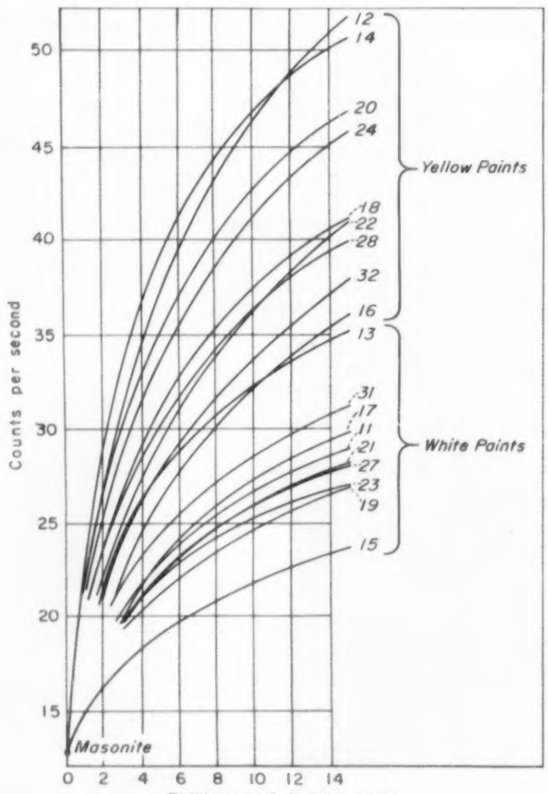



**Fig. 9.—Traffic Paints Over Masonite, Counting Rate *versus* Thickness.**

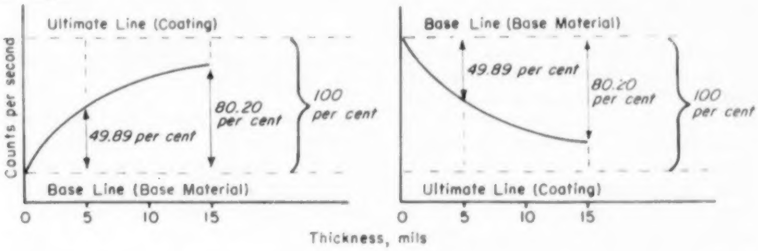
TABLE I.—PERCENTAGES FOR CONSTRUCTING EMPIRICAL CALIBRATION CURVES.

| Thickness, mils | Percentage | ASTM Dispersions ($n$ = 16) | | |
|---|---|---|---|---|
| | | Standard Deviation, $\sigma$, per cent | Coefficient of Variation, $\nu$, per cent | Nine-tenths Error, $\pm 0.453 \times \sigma$ |
| 1........ | 17.55 | 3.55 | 20.20 | 1.61 |
| 2........ | 28.71 | 3.59 | 12.50 | 1.63 |
| 3........ | 37.49 | 4.04 | 10.79 | 1.83 |
| 4........ | 44.22 | 4.32 | 9.76 | 1.96 |
| 5........ | 49.89 | 4.30 | 8.62 | 1.95 |
| 6........ | 54.71 | 4.39 | 8.00 | 1.99 |
| 7........ | 58.90 | 4.43 | 7.52 | 2.01 |
| 8........ | 62.59 | 4.40 | 7.04 | 1.99 |
| 9........ | 65.94 | 4.45 | 6.74 | 2.02 |
| 10........ | 68.90 | 4.35 | 6.31 | 1.97 |
| 11........ | 71.61 | 4.24 | 5.92 | 1.92 |
| 12........ | 74.04 | 4.32 | 5.83 | 1.96 |
| 13........ | 76.31 | 4.12 | 5.40 | 1.87 |
| 14........ | 78.33 | 4.12 | 5.26 | 1.87 |
| 15........ | 80.20 | 4.00 | 4.99 | 1.81 |

Explanation:

If at the stated thicknesses the difference is considered between the counting rate at infinite thickness of the uncoated base material (base line) and the counting rate at infinite thickness of the coating material (ultimate line), the above are the percentages at the stated thicknesses of coating material which the distances from base line to curve are of the total distance from base line to ultimate line.

Example:




of any given material. It makes no difference what is behind or beyond the material, because those beta rays possessing sufficient energy to pass completely through the material and become affected by what lies beyond will not have enough energy to return and leave the surface of the material at which they entered it. Those which do not traverse the material completely are unaffected by what lies beyond.

If, however, the material whose backscatter counting rate is being measured is of less than its infinite thickness, then what is behind or beyond the material becomes significant. The significance lies in a change of counting rate, and this fact affords the key to the use of the beta gage for determining the thicknesses of materials.

For example, it was found that tempered masonite yields a net backscatter counting rate of 12.85 counts per sec at infinite thickness. One may assume that a certain pavement marking paint when applied over any convenient material as a thick coat and allowed to dry (after which it is of infinite thickness or greater) yields a net backscatter counting rate of 32.67 counts per sec. If one applies a very thin but uniform coat of this paint over tempered masonite, the resulting counting rate will be slightly more than 12.85 counts per sec. Thicker coats will result in higher rates until the rate of 32.67 counts per sec is attained. The thickness at which 32.67 counts per sec is just reached is the minimum infinite thickness value for that paint.

Conversely, it was determined that a galvanized steel panel will yield a net count of 72.71 counts per sec. A light coat of the same paint will lower the rate somewhat. Heavier coats will reduce the rate more and more until again the rate of 32.67 counts per sec is reached. At the point where it is just reached the paint is again of minimum infinite thickness, the same thickness as above.

*Application to Traffic Paints:*

It was shown at the outset that the infinite thickness backscatter counting rates for the traffic paints under investigation varied in fact from 26.88 to 57.36 counts per sec, yellow paints generally having higher rates than white paints. Inasmuch as the rate at infinite thickness of portland-cement mortar was determined to be 29.50 counts per sec, it was felt desirable, from a practical standpoint, to employ a supporting ring of a material other than mortar, preferably one having a counting rate at infinite thickness as different as possible from those of the paints. This was for the purpose of obtaining maximum precision in establishing calibration curves for laboratory thickness determinations, at the same time using a supporting medium which would be satisfactorily inert to wear tests. Commercial tempered masonite gave promise of fulfilling these requirements.

Eighteen traffic paints were available, nine white and nine yellow. It was decided to use a new masonite ring for each wear test, and to apply a total of 18 stripes evenly spaced and with duplicates opposite each other. In this way it would be possible to avoid having whites and yellows on the same ring with the accompanying danger of transferring pigments. Paints were applied by doctor blade in the "as received" condition. None of the paints contained beads.

*Calibration of the Beta Gage:*

It was first necessary to construct calibration curves of counting rate *versus* thickness for the paints under consideration. Several panels were prepared of tempered masonite, measuring 3 by 6 by $\frac{1}{4}$ in. These were numbered on the back, touched up along the edges with fine garnet paper, wiped free of all loose material, weighed, and the tare weights recorded. Ten such panels were assigned to a given paint. Typically, the panels comprising a group were given a light spray coat of the appropriate paint. Effort was made to spray the paint as uniformly as possible over the entire panel, although the total amount of paint varied from panel to panel. The edges of the panels were masked off in all cases and the tape was not removed until the panels were dry. The panels were stored horizontally, face up, on shelves in a dustproof cabinet for approximately two weeks, by which time they had reached a relatively constant weight. Backscatter counting rates were then obtained, after which the panels were weighed again and the weights recorded. This procedure was repeated with second, third, fourth, and fifth coats; occasionally a sixth coat was included. When it was felt that sufficient data had been procured to establish a calibration curve of counting rate *versus* thickness (thicknesses well in excess of 15 mils), that panel having the most uniform appearance was selected and broken for accurate measurement of film depth under the microscope.

A factor was obtained by dividing the optically determined thickness in

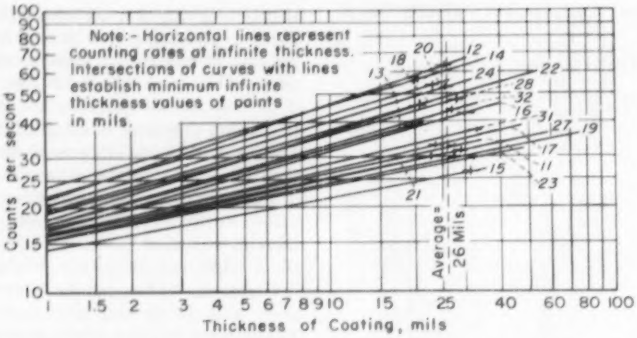



**Fig. 10.—Traffic Paints Over Masonite, Counting Rate *versus* Thickness.**

mils by the weight of the film in grams. This factor was applied to all weights recorded for the given paint for the purpose of converting weights to thicknesses. Thus, in this manner it became possible to plot final curves of counting rate against thickness for the paints under investigation.

Regardless of the fact that individual counting rates at infinite thickness were all different, all the curves tended to have the same shape, as shown in Fig. 9. Moreover, it was found that at any thickness, the ratio of counting rate at that thickness to the counting rate at infinite thickness for the same paint was approximately the same for all paints, provided the counting rate for tempered masonite alone was subtracted before calculating the ratio. After 16 of the 18 calibration curves had been plotted, the constancy of this ratio had become so apparent that it was decided not to complete the work of establishing calibration curves for the remaining two paints, but rather to construct these curves empirically.

This procedure was carried out by reading directly, from 16 calibration curves at increments of 1-mil thickness, the height of the curve above the base line (masonite counting rate at infinite thickness of masonite) and expressing that height as a percentage of the ultimate height (paint counting rate at infinite thickness of paint). All 16 percentages thus obtained from the different paints were averaged at each mil thickness of paint film. In this manner there were obtained out of a universe of 16 traffic paints a series of percentages which it was hoped would be useful in setting up calibration curves for other paints, even when applied over materials other than masonite, provided only that counting rates at infinite thickness of paint and supporting material be known. These percentages are listed in Table I.

Curves for the two remaining paints were constructed on the basis of these percentages. Experimental panels were prepared, cured, counted, and broken. In the case of each paint, thickness determined from the empirical curve compared perfectly with thickness measured under the microscope by other operators.

When plotted on logarithmic coordinate paper, the calibration curves resulted in straight lines, as shown in Fig. 10. When extrapolated to values at infinite thickness, the points of intersection of these lines with the counting rates at infinite thickness gave an average value of approximately 26 mils as mean minimum thickness at infinite thickness for the 18 paints investigated.

All determinations of backscatter counting rates of paints at infinite thickness were conducted using specimens prepared by pouring layers of paint which dried to a minimum thickness of $\frac{1}{8}$ in. Each determination was based on 256,000 counts, with corresponding statistical accuracy of ±0.198 per cent. Rates of specimens of less than infinite thickness used in establishing the calibration curves were based on 25,600 counts for each determination, with statistical accuracy of ±0.625 per cent. Inaccuracies, other than statistical, include errors caused by the difficulty of spraying successive coats of paint uniformly, uncertainties introduced by the curing periods employed, and nearly negligible effects due to slight deterioration of the source within the duration of the research. Any tendency for the gage to sink into a thick layer of paint (or other coating) and thereby reduce the scatterer-to-source-tube distance is minimized by the design. Only the weight of the counter tube, plastic supporting tubes, rings, and the source holder rests directly on the paint film. This slight pressure is largely offset by provision of an extra bearing surface for contact with the paint in the form of a $\frac{1}{2}$-in. band of plastic measuring $2\frac{1}{4}$ in. outside diameter and $1\frac{3}{4}$ in. inside diameter. The latter dimension establishes the circle of backscatter count, or effective aperture of the instrument.

As shown in Fig. 11, the calibration curves may also be plotted in accordance with the general activity formula (**5**):

$$\frac{A_i - A_x}{A_i} = e^{-kx}$$

where:

$A_i$ = activity at infinite thickness (100 per cent),
$A_x$ = activity at thickness $x$, per cent,
$k$ = composite backscatter factor, and
$x$ = thickness.

In this plot, thicknesses are in mils, not in mg per sq cm, thus, as densities are ignored, accounting for the wide differences among paints. Values of $k$ are plotted against values of $x$ on logarithmic coordinate paper. It is noteworthy that although curves for individual paints deviate from linearity, that representing the average of all the paints is practically straight.

In the equation, $x$ is the independent variable and $A_x$ the dependent variable. In equations of this type, $k$ is ordinarily a constant whose value, assuming stable geometry irrespective of $x$, depends upon the nature of the material (in this case, paint) and hence upon the range of the beta particles in the material. The fact that the value of $k$ varies with the thickness indicates that the paint film is not homogeneous from top to bottom. One of the most

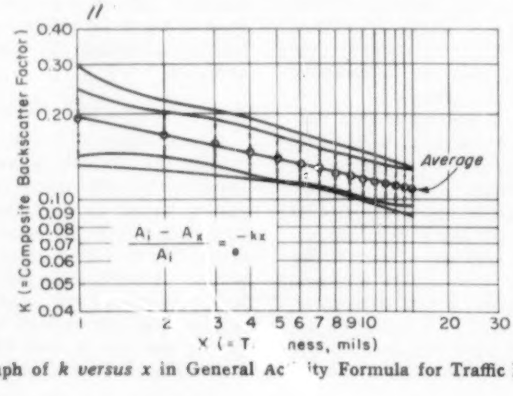



**Fig. 11.—Graph of *k versus x* in General Ac ity Formula for Traffic Paints Studied.**

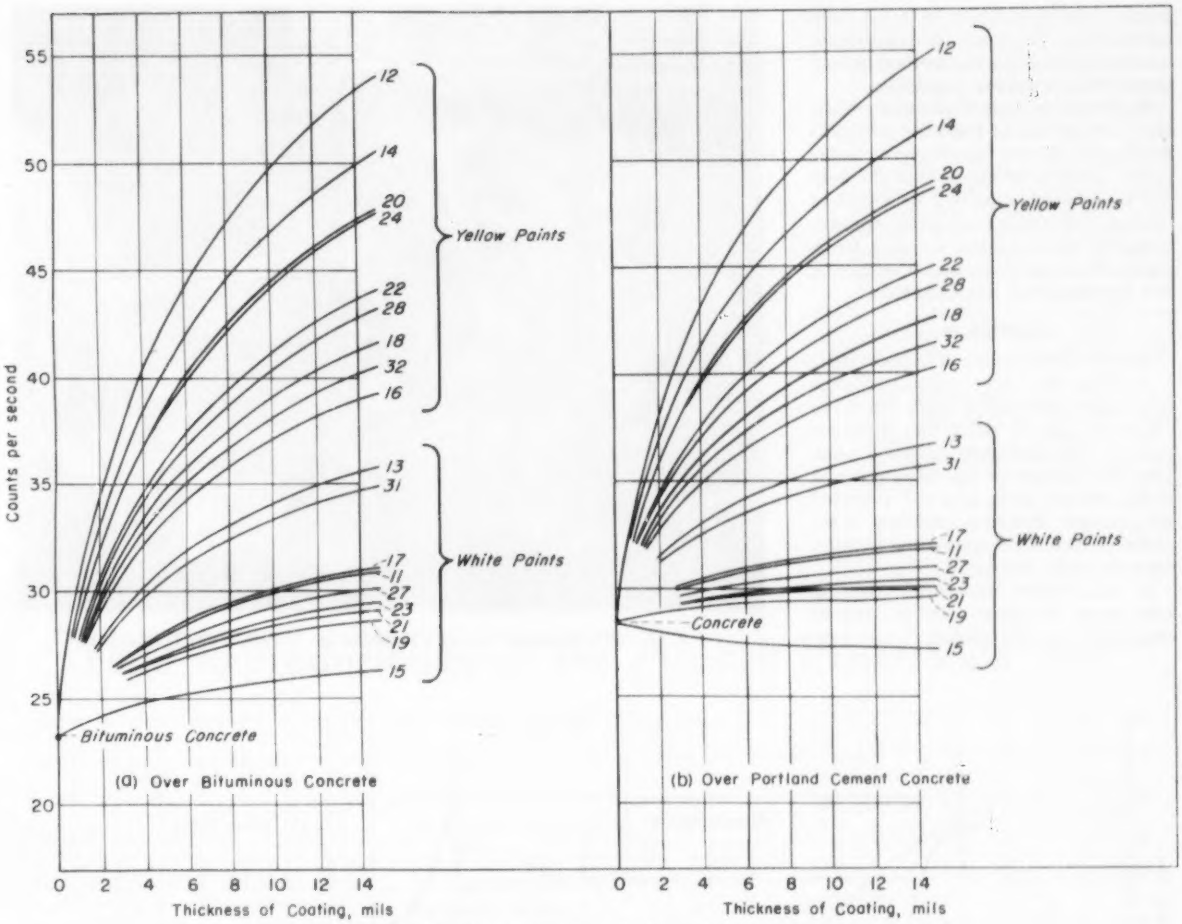



**Fig. 12.—Counting Rate *versus* Thickness for Traffic Paints.**

important factors contributing to the heterogeneity of paint films is volatilization of vehicle constituents from the surface, with resulting shrinkage. It is reasonable to expect, therefore, that the degree to which the slope of the $k$ *versus* $x$ plot approaches zero (the degree to which $k$ approaches a constant, independent of the value of $x$) is a measure of the extent of paint cure. If future experiments substantiate this, the $k$ slope might well comprise a useful standard measure of this variable.

*Calibration Curves for Field Use:*

Figure 12 shows calibration curves for the same paints on bituminous concrete and portland-cement concrete, respectively. These curves were constructed empirically by use of the percentages listed in Table I.

#### Results Using Radioactivity

Once calibration curves of backscatter counting rate *versus* thickness had been established for nine white and nine yellow traffic paints, the laboratory was in a position to use these for evaluating results of wear tests, as shown in Fig. 13. Figure 14 shows the results of the wear tests on white paints, each point representing the average thickness of two paint stripes. Curing time prior to abrasion was three weeks at room temperature.

Original dry film thicknesses for the nine white paints varied from $5\frac{1}{4}$ to $10\frac{1}{2}$ mils. Obviously, it would be difficult to appraise traffic paint wear by means of a grid on the assumption that all stripes started out at the same thickness, when actually some were twice as thick as others. This finding was confirmed and extended in a corresponding wear test on the nine yellow traffic paints, the results of which are shown in Fig. 14. Original yellow stripe thicknesses ranged from 4 to 19 mils.

With the exception of paints Nos. 11 and 27, all the white paints followed the same general pattern of wear. Paint No. 11 appeared to be outstanding in its resistance to the type of abrasion employed. Paint No. 27 followed the general over-all wear pattern, but its reduction in film thickness was irregular. This paint was the only one applied in two coats, with 24-hr drying between coats. The mode of its application is apparent in the wear curve, which indicates a definite increase in wear resistance as the relatively cured (and therefore harder) surface of the first coat became exposed.

#### Future Applications

The apparatus was developed with a view toward portability. The gage was designed so that it could be used in the field, with a portable or mobile generator, and with a pre-amplifier to compensate for a longer lead to the scaler. (No pre-amplifier was used in the applications here reported.) Whether or not pavement surfaces will prove to be sufficiently plane and homogeneous for acceptable statistical measurements to be made is still to be determined. Also, calibration curves for

paints containing beads have not been established. However, the possibilities inherent in applying the method to field measurements appear hopeful.

Furthermore, actual abrasion resistance is only one of the several factors responsible for the durability of traffic paint. It is to be hoped that the beta ray backscatter gage will be useful in studies of chipping from pavement surfaces, the effects of dew, solvents, freezing and thawing cycles, and other factors not yet completely investigated.

## Conclusions

Results of this research indicate that:

1. The beta ray backscatter gage is a useful instrument with which to follow changes in paint film thickness produced by laboratory abrasion tests. Dry film thicknesses can be determined to the nearest tenth of a mil, provided the infinite thickness counting rates of the paint and the supporting medium are sufficiently different.

2. Calibration curves of counting rate *versus* thickness can be plotted empirically for any coating on any sup-

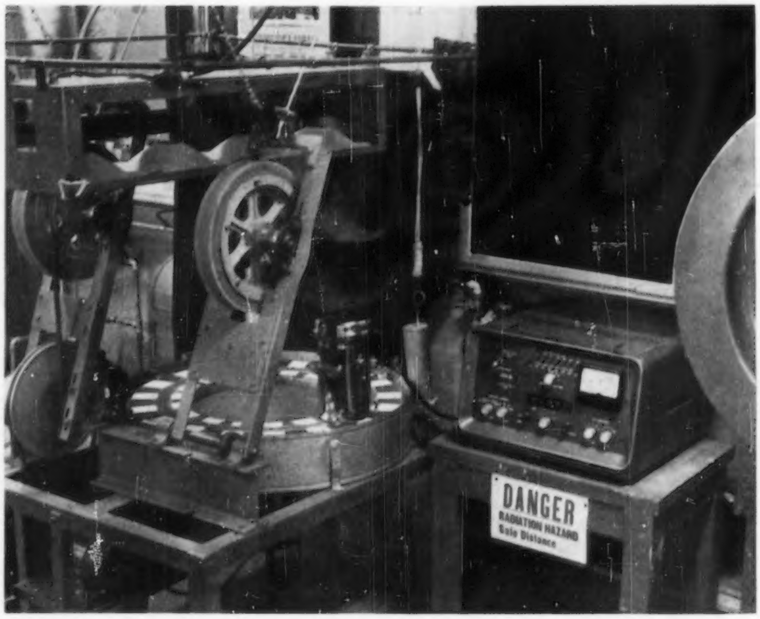
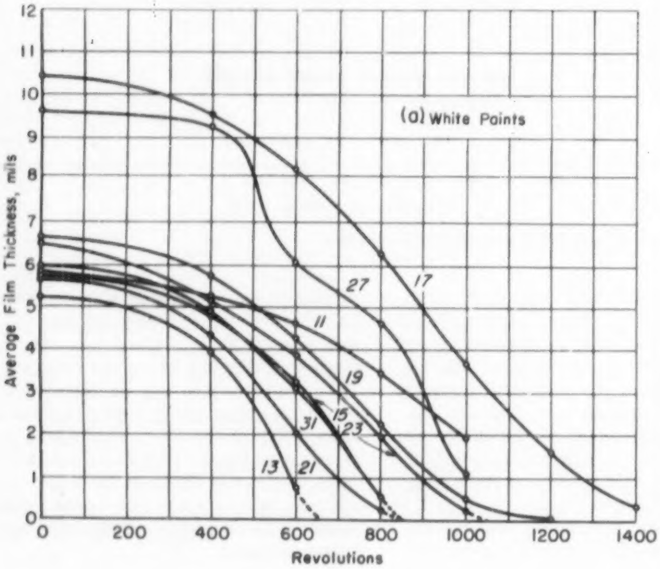



Fig. 13.—Beta Gage in Use for Determination of Paint Film Thicknesses.



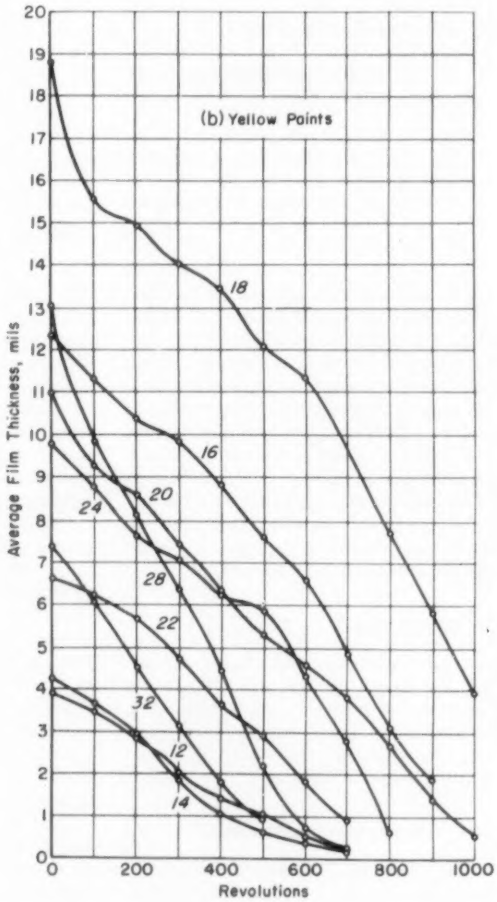




Fig. 14.—Abrasion Resistances of Traffic Paints.

porting medium provided only that the following conditions be fulfilled: (1) that the coating and its support have different effective atomic numbers, and (2) that the beta ray backscatter counting rate at infinite thickness for both materials be known.

3. The average minimum infinite thickness of 18 traffic paints investigated was 26 mils, using the Michigan gage charged with strontium 90.

4. Common engineering materials tend to form generic groupings when arranged by beta ray backscatter counting rates according to effective atomic numbers. Those of similar bulk specific gravities tend to form generic groupings when arranged according to beta ray backscatter counting rates.

*Acknowledgments:*

The author acknowledges indebtedness to the following individuals for their encouragement and assistance in this research: Ralph T. Overman, chairman of the special training division, Oak Ridge Institute of Nuclear Studies; Henry J. Gomberg, assistant director of the University of Michigan Phoenix Memorial Project; Lester F. Wolterink, professor of physiology and pharmacology and chairman of the isotope committee of Michigan State College; and J. C. Lee, assistant professor of physics, Michigan State College.

References

(1) Lloyd R. Zumwalt, "Absolute Beta Counting Using End-Window Geiger-Mueller Counters and Experimental Data on Beta-Particle Scattering Effects," United States Atomic Energy Commission, AECU-567, Oak Ridge National Laboratory, March 13, 1950.

(2) Erick Clarke, J. R. Carlin, and W. E. Barbour, Jr., "Measuring the Thickness of Thin Coatings With Radiation Backscattering," *Electrical Engineering*, January, 1951, pp. 35–37.

(3) Gerhart Friedlander and Joseph W. Kennedy, "Introduction to Radiochemistry," John Wiley & Sons, Inc., New York, N. Y., p. 165 (1951).

(4) L. R. Zumwalt, "The Best Performance from Beta Gages," *Nucleonics*, Vol. 12, No. 1, January, 1954, pp. 55–58.

(5) G. K. Schweitzer and I. B. Whitney, "Radioactive Tracer Techniques," D. Van Nostrand Co., Inc. New York, N. Y., p. 114 (1949)

# Field Reproducibility of the Asphalt Penetration Test

By L. W. Corbett

***Variation in penetration tests results on bituminous materials was found to be primarily attributable to measurement errors with smaller variation effects due to sampling technique, the asphalt itself, or to both.***

The test for penetration of bituminous materials[1] as applied to asphalt cements can be reproduced within a reasonable degree in temporary field laboratories. The variation that was observed can be attributed primarily to measurement errors with smaller variations due to sampling techniques, to the asphalt itself, or to both. This was illustrated during the normal course of inspection and approval of approximately 3000 shipments of asphalt cement used on the Garden State Parkway in New Jersey during the 1954 season.

At one period during construction five hot-mix plants were receiving asphalt cement of 85–100 penetration grade from one refinery lot and tank source. Two to four transports were serving each of these plants, and as far as could be determined were being used exclusively for this project. Each hot-mix plant was controlled by a temporary field laboratory equipped for testing aggregates, asphalt, and asphalt mixes. One of these laboratories tested asphalt shipments for two of the plants, it being better equipped for the penetration test. Each truck shipment was sampled and checked for penetration at 77 F and for flash point. Within the four field laboratories reporting on this lot of asphalt cement, seven different technicians were involved, only one of whom had an appreciable background in testing asphalt. The others were mostly young men of high school education or first- or second-year, "summer-job," college men who were being trained for the first time in the testing of these materials. Most of the testing equipment was new. It had to be installed and used under field conditions in small frame buildings to which were added the necessary utilities.

During the six-day period that shipments were made from this particular lot each laboratory collected extra samples. These samples were poured from the same larger sample taken by the field laboratory for their routine tests. In all, 55 samples were taken at random out of 100 truck shipments sampled and tested by the laboratories. The 55 special samples were then tested by one experienced tester using a refinery control laboratory and equipment. The 100 samples, of course, were tested by the various seven testers in the four field laboratories. The ASTM Standard Method of Test for Penetration of Bituminous Materials[1] was followed precisely for control testing on the special samples. The same procedure was outlined for use by the testers in the field.

The results of this testing are summarized in Table I, which includes the number of tests reported, the average,

**L. W. CORBETT, Consultant on Asphalt Technology, has been with Miller-Warden Associates, Swarthmore, Pa., since 1953. His prior experience includes 13 years in research and development in industry, mostly on asphalts.**

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Standard Method of Test for Penetration of Bituminous Materials (D 5 – 52), 1952 Book of ASTM Standards, Part 3, p. 1331.

TABLE I.—SUMMARY OF DETERMINATIONS ON 85-100 PENETRATION ASPHALT CEMENT.

| Field Laboratory | Number of Tests | Average, $\bar{X}$ | Range, R | Standard Deviation, $\sigma'$ |
|---|---|---|---|---|
| **Field Laboratory Tests on Truck Samples (Seven testers involved)** | | | | |
| A...... | 24 | 93.9 | 9 | 2.3 |
| B...... | 24 | 95.6 | 9 | 2.7 |
| C...... | 38 | 90.1 | 7 | 1.3 |
| D...... | 14 | 94.3 | 9 | 3.0 |
| All labs.. | 100 | 92.9 | 10 | 3.2 |
| **Control Laboratory Tests on Truck Samples (One tester involved)** | | | | |
| A...... | 16 | 94.8 | 4 | 1.5 |
| B...... | 18 | 94.9 | 4 | 1.1 |
| C...... | 11 | 95.6 | 6 | 1.7 |
| D...... | 10 | 94.9 | 4 | 1.2 |
| All labs.. | 55 | 95.0 | 7 | 1.4 |

the range, and the standard deviation for each of the laboratories.

As would be expected, the control laboratory tests were much less variable, and a grand average of 95.0 penetration was found on the 55 special samples. The standard deviation of each of these groups was also quite uniform. The field laboratory tests on the other hand offer an interesting comparison. Laboratory C had a low average which upon investigation revealed that a damaged needle was being used. By cross checking, it was proved that this instrument with the damaged needle was giving low results on an average of three penetration points. If this were applied as a correction the average for that laboratory would be 93.1 and the average for all tests in the field would be 94.1. By the ASTM Standard, the test results should be reproducible within a range of ±4 of the average. This condition was not always met when considering the results reported on individual samples and as indicated by the range values in Table I. However, it should be remembered that we did not have the ideal situation in which subsamples were taken from a well-mixed and controlled master sample. Instead 100 samples were taken from 100 truck tanks which were loaded from the same refinery tank over a period of 6 days.

Range and standard deviation provide a measure of the variability of each group of tests, and it is interesting to note that Laboratory C showed less variation even though its average proved to be low.

Asphalt cement grades are frequently made by blending, but it is an easy matter to make and maintain them in an essentially homogeneous state. Contamination in refinery storage and in shipment are always possible, but this source of variation is not likely in this case because there was no trend in test values from the first to the last day of shipment. Variation in sampling technique and in maintenance of sampling containers could have influenced the results although it was not possible to prove this point. This leaves the method of measurement as the most logical source of variation.

The variability of the measured value can be related to the precision of the method of measurement by use of the following formula **(1)**:[2]

$$\sigma'_{\text{measured value}} = \sqrt{(\sigma'_{\text{true value}})^2 + (\sigma'_{\text{error of measurement}})^2}$$

In other words, the variability observed in the measured values of penetration is due in part to the variability of the product and in part to the method of measurement. With experience, a tester can ordinarily indicate with what precision he can perform a test. This can be put into a measureable form by calculating the standard deviation **(2)** of the error of measurement, determined by previous experience to be 0.6. The measured value of standard deviation of the control laboratory results was found to be 1.4, from which the true value can be approximated to be 1.3 when rounded off. This means that we would still have a sizable variation in the penetration of the asphalt as received under these conditions of sampling, even though errors in testing were nonexistent. By use of the true value of standard deviation just estimated along with the observed value from field laboratory tests, we can now determine the standard deviation of error of measurement for field testing. The following table summarizes the values of standard deviation found.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

TABLE II.—SUMMARY OF STANDARD DEVIATION VALUES.

| | |
|---|---|
| Field laboratory observed value.... | 3.2 |
| Field laboratory error of measurement.......... | 2.9 |
| Control laboratory observed value.. | 1.4 |
| Control laboratory error of measurement.......... | 0.6 |
| True value of variation.......... | 1.3 |

## Conclusions

The experience and analysis resulting from this series of tests indicates that with periodic supervision we can expect a reasonable degree of reproducibility by the field laboratories. Certainly this ability is sufficient to catch any shipment that seriously deviates from the specifications. Variation in test results is primarily attributable to measurement errors with smaller variation effects due to sampling techniques, the asphalt itself, or both. It is also apparent that some individual test results will fall outside the specification limit if the asphalt is supplied with a penetration too close to either the upper or lower limit. Here again, a small deviation outside the specification limit must be attributed in a large part to the error of measurement.

### References


**(1)** E. L. Grant, "Statistical Quality Control," McGraw-Hill Book Co., Inc., New York, N. Y. (1952).

**(2)** W. J. Youden, "Statistical Methods for Chemists," John Wiley & Sons, Inc., New York, N. Y. (1951).

# Studies of Uniformity of Compressive Strength Tests of Ready Mixed Concrete*

By Delmar L. Bloem

**Concrete strength tests are subject to inherent variations which should be considered in establishing specification limits.**

STRENGTH tests of concrete are subject to certain variations which require that the concrete be over-designed to meet specifications. Information is needed on the magnitude of these variations for different types of operations in order that strength specifications may be formulated and interpreted on a realistic basis.

Measured strength of concrete specimens varies not only with fluctuations in the quality of the concrete itself, but also with lack of uniformity in sampling, molding, curing, capping, and testing strength cylinders. The variations in the concrete itself will depend upon the type and degree of control of the particular operation. In addition, wide differences will be found in testing errors among different laboratories. For the concrete to be proportioned economically to meet strength requirements, the over-all variation from all sources must be properly taken into account.

Strength tests of concrete have been shown to conform quite closely to the normal probability law.[1,2] Thus, the problem of establishing required average strengths to meet specifications is greatly simplified, once the characteristics of the strength test distribution for a given operation have been established. This report deals with analyses of strength test data to establish such information.

## Scope of Tests

During the summer of 1952, the National Ready Mixed Concrete Assn., in cooperation with the Truck Mixer Manufacturers Bureau, conducted extensive tests of concrete truck mixers at the University of Maryland. That investigation, which was intended primarily to study within-batch variations of concrete as related to such factors as amount of mixing, rate of mixing, and size of batch, involved approximately 2000 compressive strength tests of 6 by 12-in. concrete cylinders. The tests provide information on the magnitude of strength variations which might be expected for a reasonably well controlled ready-mixed concrete operation.

The investigation was conducted under circumstances that were probably no more favorable to uniformity of strength than typical ready-mixed concrete operations, and in some ways less favorable than many. The concrete was mixed in weather ranging from cool to extremely hot. Cement, although from a single mill, was received in several shipments over a period of two months. Concrete was mixed in eleven truck mixers of different sizes and types. Procedures were intentionally varied as to rate and amount of mixing and size of load to produce undermixed and adequately mixed concrete in each mixer.

On the other hand, conditions conducive to good uniformity of strength resulted from the fact that only two to four batches were mixed each day and extreme care could be taken in batching and adjusting for moisture on the aggregates. Furthermore, a staff of engineers trained in testing concrete supervised all phases of the operation to insure that standard procedures were used. All specimens were molded, cured, and tested in the laboratory with the result that possible damage from field curing or careless handling was eliminated. It is felt, therefore, that the variations in strength due to testing errors were about the minimum that could reasonably be expected.

The concrete for which data are analyzed here was made with well-graded sand and gravel of 2-in. maximum size, designed to contain $5\frac{1}{2}$ sacks of cement per cu yd and to have a slump of about 3 to 4 in. For most of the concrete, the sand content was sufficiently high to produce a degree of workability suitable for structural work. For a number of batches, the sand content was reduced to produce a degree of workability suitable for pavement or heavier sections where placement conditions are more favorable. The former has been designated as "workable" and the latter as "harsh" concrete.

In addition to the full-size batches mixed in the truck mixers, control batches were made each day in a $3\frac{1}{2}$ S-tilting mixer in the laboratory for purposes of comparison, using the same proportions and materials as for the field batches. The coarse aggregate was separated into six different sizes and recombined for each control batch to eliminate segregation. A procedure of "integral buttering" was employed to compensate for mortar hold-back in the small laboratory mixer, and there is some evidence that this practice gave the laboratory batches a slight advantage in strength.

From each of the field batches, a total of eighteen 6 by 12-in. cylinders were molded—six from the first, middle, and final third of the batch. Of the six from each third, three were tested at 7 days and three at 28 days. From the control batches, two sets of three cylinders each were molded for tests at 7 and 28 days.

**DELMAR L. BLOEM, Assistant Director of Engineering, National Sand and Gravel Assn. and National Ready Mixed Concrete Assn., Washington, D. C., is an active member of ASTM Committee C-9. He has been closely associated with concrete research and testing for the past 10 years.**

**NOTE.**—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* This report was prepared in behalf of Subcommittee II-a on Evaluation of Data of ASTM Committee C-9 on Concrete and Concrete Aggregates.

[1] Stanton Walker, "Application of Theory of Probability to Design of Concrete for Strength Specifications," National Ready Mixed Concrete Association (1944).

[2] Neils M. Plum, "Quality Control of Concrete—Its Rational Basis and Economic Aspects," Institution of Civil Engineers, *Paper No. 5879*, London (1953).

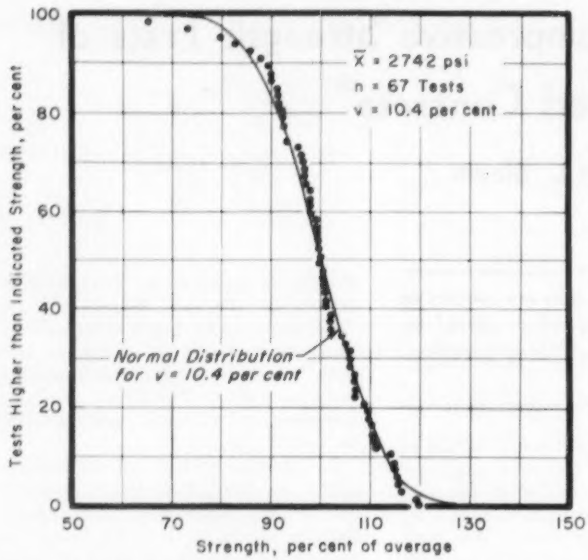



**Figure 1.—Ogive Curve for Average 7-Day Compressive Strengths of Field Batches of Workable Concrete.**

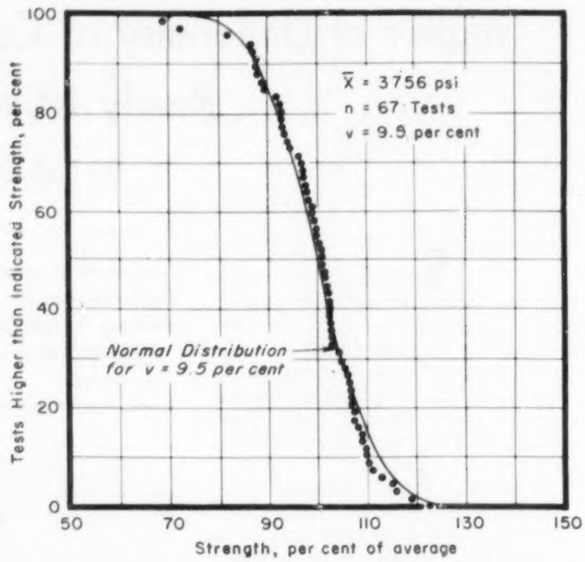



**Figure 2.—Ogive Curve for Average 28-Day Compressive Strengths of Field Batches of Workable Concrete.**

## Discussion of Data

That the compressive strength of a given class of concrete conformed quite well to the normal probability distribution is demonstrated in Figs. 1 and 2, which show ogive curves for 7- and 28-day tests, respectively, of workable concrete mixed in the truck mixers. The coefficients of variation for both test ages were approximately the same—about 10 per cent.

Table I gives statistical data for both 7- and 28-day tests of workable and harsh concrete mixed in the laboratory and in the field. Strengths and coefficients of variation are given on two bases. In the upper half of the table, a strength test has been taken as the average of all nine cylinders from each batch. In the lower half of the table, the data are based on the single middle cylinder from each batch—that is, the cylinder that was fifth in order of fabrication for field batches and second for laboratory batches.

On the basis of average strengths from each batch, the tests of laboratory concrete were not significantly more reproducible than those of the field concrete. In the case of the 7-day tests of workable concrete, the coefficient of variation was less for the laboratory concrete (7.7 per cent) than for the field concrete (10.4 per cent). This difference would be considered significant if it were not for the fact that the coefficient of variation for 28-day tests of this same class of concrete was essentially the same in the laboratory as in the field (9.4 and 9.5 per cent, respectively). For the harsh concrete, there was no consistent difference in coefficient of variation between the laboratory and field specimens. For reasons not readily apparent, coefficients of variation were slightly less, by about 1.5 percentage points on the average, for the harsh concrete than for workable concrete.

It appears from the average test results that, in this investigation, the factors contributing to strength test variations were about the same in the laboratory as in the field. These factors were probably minor variations in mixing water (as evidenced by some variation in slump in both laboratory and

TABLE I—SUMMARY OF COMPRESSIVE STRENGTH TEST DATA FROM INVESTIGATION OF CONCRETE TRUCK MIXERS.

All concrete made with 2-in. maximum size aggregate and designed to contain 5.5 sacks of cement per cu yd with slump of 3 to 4 in. "Workable" concrete was typical of that which would normally be used in structures; "harsh" concrete contained less sand and was typical of that used in pavements.

Field batches were mixed in 11 different truck mixers ranging in capacity from 2½ to 5½ cu yd; laboratory batches were mixed in a 3½ S-tilting mixer.

Cylinders molded, capped, cured, and tested in accordance with ASTM standard procedures.

| Source of Concrete | Class of Concrete | Age at Test, days | Number of Tests, $n$ | Number of Cylinders per Test | Avg Compressive Strength, $\bar{X}$, psi | Coefficient of Variation, $v$, per cent[a] |
|---|---|---|---|---|---|---|
| Data Based on Averages of All Cylinders from Each Batch | | | | | | |
| Field... | Workable | 7 | 67 | 9 | 2742 | 10.4 |
| | | 28 | 67 | 9 | 3756 | 9.5 |
| | Harsh | 7 | 21 | 9 | 3063 | 8.8 |
| | | 28 | 21 | 9 | 4070 | 6.9 |
| Lab.... | Workable | 7 | 24 | 3 | 3088 | 7.7 |
| | | 28 | 24 | 3 | 4184 | 9.4 |
| | Harsh | 7 | 9 | 3 | 3275 | 6.9 |
| | | 28 | 9 | 3 | 4272 | 8.2 |
| Data Based on Middle Cylinder Only from Each Batch | | | | | | |
| Field.... | Workable | 7 | 65 | 1 | 2716 | 12.6 |
| | | 28 | 66 | 1 | 3735 | 11.9 |
| | Harsh | 7 | 21 | 1 | 3012 | 9.6 |
| | | 28 | 20 | 1 | 4075 | 9.8 |
| Lab.... | Workable | 7 | 21 | 1 | 3077 | 9.2 |
| | | 28 | 24 | 1 | 4231 | 9.8 |
| | Harsh | 7 | 9 | 1 | 3271 | 6.0 |
| | | 28 | 9 | 1 | 4337 | 9.5 |

[a]
$$v = \frac{\sqrt{\frac{\Sigma X^2}{n} - \bar{X}^2}}{\bar{X}}(100)$$

where: $X$ = compressive strength, psi (individual values), $\bar{X}$ = average compressive strength, psi, and $n$ = number of tests. (See ASTM Manual on Quality Control of Materials, Am. Soc. Testing Mats., p. 15 (1951). (Issued as separate publication, *ASTM STP No. 15-c.*))

field), use of different shipments of cement, and the unavoidable slight variations in molding, capping, curing, and testing of cylinders.

Considering that the field concrete was purposely mixed under varying conditions as to type of mixer, rate and amount of mixing, size of batch and method of loading, the coefficients of variation, which ranged from about 7 to 10 per cent, seem encouragingly low. In laboratory research, a value of 5 per cent is usually as low as can be obtained.

If we assume that, under field conditions, the coefficient of variation can reasonably be held to 10 per cent, we have a basis for determining the amount of overdesign required to meet typical strength specifications.[3] Assuming normal distribution, we can calculate for the 10 per cent coefficient of variation that, to insure 9 out of 10 tests exceeding a specified strength, the average strength must be 15 per cent higher than that specified. To increase the number meeting the specification to 99 out of 100, we must have an average strength 30 per cent higher than that specified. In other words, to produce "3000-lb" concrete, we would have to design for an average strength of either 3450 or 3900 psi, depending upon whether 9 out of 10 or 99 out of 100 tests would be expected to exceed 3000 psi.

Figures 3 and 4 show the ogive curves for tests at 7 and 28 days, respectively, of single cylinders from the field batches of workable concrete. These curves are comparable with Figs. 1 and 2, but each point represents only the one cylinder from the middle of the batch rather than the average of all nine cylinders from the batch. Here again, the data conform well to the normal distribution, but, as would be expected, the coefficients of variation are greater than for the average results. The latter is true, with one exception, for single-cylinder results for the other test conditions, as shown in the lower portion of Table I. The exception is for 7-day tests of harsh concrete mixed in the laboratory where the coefficient of variation for single cylinders was very slightly less than for the averages of 3 cylinders per batch.

What is surprising about the single-cylinder data is that the coefficients of variation are not larger. For field batches, they exceed values from the average data by only about 2 percentage points and, for laboratory batches, by less than 1 percentage point on the average. This would suggest that the usual requirement that at least three cylinders constitute a test is unnecessary and that single cylinders would serve nearly as well.[4] However, that conclusion cannot be accepted without serious reservations. It must be remembered that these tests were made under highly favorable conditions so far as concerned the skill of personnel, easy access to laboratory equipment, careful protection and curing of specimens, and uniformity of treatment at all stages. In other words, it seems fair to assume that the likelihood of obtaining very erratic single cylinders was much less than would typically be the case in the field. Therefore, it should not be inferred that the present requirement that three cylinders constitute a test can be disregarded.

The reason for the small difference in coefficients of variation between single cylinders and averages can be illustrated mathematically from the well-known relationship,

$$v = \sqrt{v_1^2 + v_2^2}$$

where:

$v$ = over-all coefficient of variation (of single specimens),

$v_1$ = within-batch coefficient of variation, and

$v_2$ = batch-to-batch coefficient of variation.

[3] "Control of Quality of Ready Mixed Concrete," National Ready Mixed Concrete Assn, *Publication No. 44*, 3rd Ed., June, 1953. (See chapter on "Over-Design to Meet Specifications.")

[4] R. W. Crum and H. W. Leavitt, "The Numbers of Specimens or Tests of Concrete and Concrete Aggregates Required for Reasonable Accuracy of the Average," Report on Significance of Tests of Concrete and Concrete Aggregates, Am. Soc. Testing Mats., p. 163 (1943). (Issued as separate publication *ASTM STP No. 22-a*.)

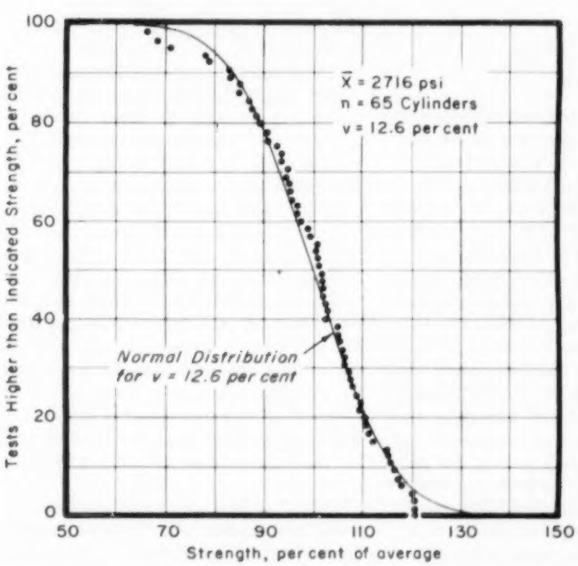



**Figure 3.—Ogive Curve for 7-Day Compressive Strength Tests of Middle Cylinder from Field Batches of Workable Concrete.**

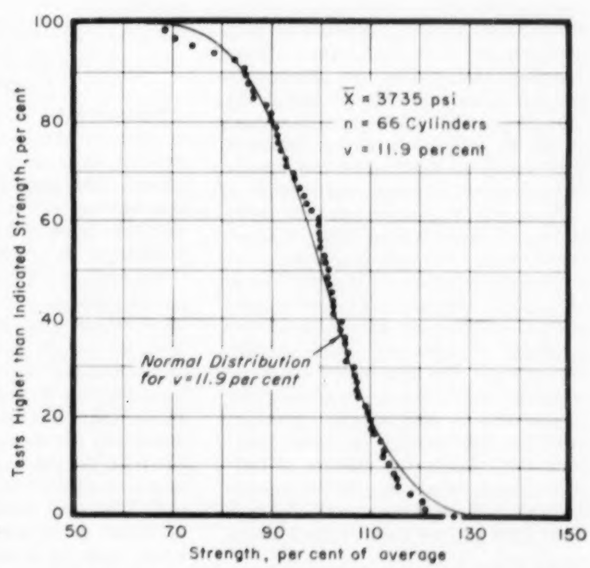



**Figure 4.—Ogive Curve for 28-Day Compressive Strength Tests of Middle Cylinder from Field Batches of Workable Concrete.**

TABLE II.—STATISTICAL DATA ON STRENGTH TESTS OF CONCRETE.
See Table III for information on nature of jobs, concrete control, and testing procedures.

| Job | Number of Tests[a] | 28-Day Compressive Strength, psi | | | Standard Deviation, psi[b] | Coefficient Variation, per cent[c] | Mean Variation, per cent[d] | Required Average Strength, per cent Specified Strength[e] | | Percentage of Tests Higher than:[f] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | High | Low | Avg | | | | 9 in 10 | 99 in 100 | 70 per cent | 80 per cent | 90 per cent |
| No. 1 | 58 (2) | 4680 | 3270 | 4061 | 285 | 7.0 | 5.4 | 110 | 119 | 99+ | 99+ | 92 |
| No. 2 | 30 | 4705 | 2724 | 3514 | 487 | 13.9 | 11.6 | 122 | 148 | 99 | 93 | 75 |
| No. 3 | 105 (2) | 4430 | 2400 | 3340 | 485 | 14.5 | 12.1 | 123 | 152 | 98 | 92 | 74 |
| No. 4 | 63 (3) | 4200 | 1160 | 2195 | 517 | 23.6 | 16.7 | 144 | 222 | 90 | 80 | 66 |
| No. 5 | 94 (1) | 5306 | 2830 | 3949 | 444 | 11.2 | 8.9 | 117 | 135 | 99+ | 96 | 81 |
| No. 6 | 126 (1) | 5870 | 2970 | 4370 | 546 | 12.5 | 10.2 | 119 | 141 | 99+ | 95 | 78 |
| No. 7 | 98 (1) | 4920 | 2670 | 3467 | 486 | 14.0 | 11.2 | 122 | 149 | 99 | 92 | 75 |
| No. 8 | 31 (1) | 2750 | 2000 | 2207 | 173 | 7.8 | 6.0 | 111 | 122 | 99+ | 99 | 90 |
| No. 9 | 82 (1) | 3890 | 1990 | 2721 | 290 | 10.7 | 8.3 | 116 | 133 | 99+ | 97 | 82 |
| No. 10 | 49 (1) | 6785 | 2650 | 5234 | 788 | 15.1 | 11.5 | 124 | 155 | 98 | 91 | 73 |
| No. 11 | 26 (1) | 5100 | 3460 | 4187 | 419 | 10.0 | 8.0 | 115 | 130 | 100− | 98 | 84 |
| No. 12 | 48 (1) | 5040 | 3875 | 4442 | 326 | 7.3 | 6.4 | 110 | 120 | 100− | 100− | 91 |
| No. 13 | 40 (1) | 5760 | 3365 | 4532 | 514 | 11.3 | 8.7 | 117 | 136 | 100− | 96 | 81 |
| No. 14 | 43 (1) | 5520 | 3280 | 4548 | 455 | 10.0 | 7.8 | 115 | 130 | 100− | 98 | 84 |
| No. 15 | 57 (2) | 3203 | 2470 | 2860 | 171 | 6.0 | 4.6 | 109 | 116 | 100− | 100− | 95 |
| No. 16 | 100 (1) | 4190 | 2880 | 3536 | 272 | 7.7 | 5.9 | 111 | 121 | 100− | 99 | 90 |
| No. 17 | 100 (1) | 3650 | 2930 | 3120 | 267 | 8.6 | 6.6 | 113 | 125 | 99+ | 99 | 88 |
| No. 18 | 100 (1) | 4000 | 1770 | 2566 | 277 | 10.8 | 7.5 | 116 | 134 | 99+ | 97 | 82 |
| No. 19 | 100 (1) | 2230 | 980 | 1785 | 231 | 12.9 | 9.9 | 120 | 143 | 99 | 94 | 78 |
| No. 20 | 79 (2) | 3176 | 1898 | 2696 | 350 | 13.0 | 10.5 | 120 | 144 | 99 | 94 | 77 |

[a] (1), (2), (3) indicate number of cylinders comprising a single test. Lack of number indicates "not known," probably one cylinder.

[b] $\sqrt{\frac{\Sigma x^2}{n}}$

where: $x$ = deviation of individual values from average, and $n$ = number of tests.

[c] $\frac{\text{Standard deviation}}{\text{Average strength}}(100)$.

[d] $\frac{\Sigma x}{n\ (\text{average strength})}(100)$.

[e] Design average strength required to insure probability that 9 tests out of 10 or 99 out of 100 will be higher than a specified strength—per cent of specified strength.

[f] Percentage of tests that may be expected to be higher than 70, 80, or 90 per cent of the average strength (based on coefficient of variation).

For the approximate over-all coefficient of variation of 12 per cent and batch-to-batch coefficient of variation of 10 per cent shown by these tests, the within-batch coefficient of variation is found to be about 7 per cent, a reasonable value for carefully made field tests. Where sampling and testing are done with less care, as is frequently the case in the field, the contribution of testing variations to over-all variation becomes greater and single-cylinder test results become correspondingly less reliable.

With due allowance for their limitations, it appears that tests of single cylinders could be used to advantage as an over-all indication of strength. Such tests might even be used for acceptance purposes if provision were made for the possibility of occasional erratic results. For example, the apparently minor increase in coefficient of variation from 10 per cent for sets of nine specimens to 12 per cent for single cylinders would more than double the number of tests falling below 80 per cent of the average strength. Thus, if the average strength were 5000 psi, we could expect about 2 tests in 100 to fall below 4000 psi where multiple cylinders were used, whereas, if strengths were measured by single cylinders, about 5 would be below 4000 psi.

### Data from Various Types of Operation

Further data on the reproducibility of strength tests are given in Table II, which shows statistical information for several field and laboratory projects.[5] Descriptions of the nature of the various jobs, types of concrete, and testing procedures are given in Table III.

The data in Table II indicate that considerable variation in reproducibility of strength tests should be expected from job to job, even in similar types of operations. For example, eight of the jobs, Nos. 1, 2, 8, 9, 11, 12, 13, and 14, were supplied with ready-mixed concrete and, for these, the coefficients of variation ranged from a low of 7.0 per cent to a high of 14.5 per cent. What such differences in reproducibility mean in terms of economy of production, where strength is the basis for acceptance, is demonstrated in the right-hand portion of the table. To insure a 99 in 100 probability of a test being above a given strength, only 19 per cent overdesign is required for the lower coefficient of variation while 52 per cent is required for the higher value. The difference in overdesign could account, in a typical case, for as much as 1 to 1½ sacks of cement per cu yd of concrete.

For field jobs involving other than ready-mixed concrete (Nos. 4, 5, 6, 7, and 10), coefficients of variation ranged from 11.2 to 23.6 per cent. In evaluating these figures, it should be kept in mind that some of these data for job-mixed concrete are rather old (1923 to 1943) and that control procedures have undoubtedly been improved in recent years. The very high coefficient of variation of 23.6 per cent for job No. 4 represents concrete for which the ingredients were measured by volume. Actually, there seems to be no reason to suppose that either job-mixed or ready-mixed concrete should be inherently more uniform than the other.

Data for the pilot and laboratory tests (Nos. 15 through 20) show a rather large range in coefficients of variation, from 6 to 13 per cent. It is interesting to observe that, in the four groups of

[5] These data were compiled for Subcommittee II-a several years ago, but are published here for the first time.

TABLE III.—DESCRIPTION OF JOBS, TYPES OF CONCRETE, AND NUMBER OF SAMPLES (FOR TESTS SHOWN IN TABLE II).

| Job | Description |
|---|---|
| No. 1 | Reinforced concrete building. Ready-mixed concrete. Coarse aggregate—1-in. gravel; Cement factor—6.38 sacks per cu yd; slump—max 9.0 in., min 4.0 in., avg 6.7 in. Two 6 by 12-in. cylinders molded from each of 58 batches during the period June 19 to July 22, 1937. Strengths average of 28-day tests of each pair of cylinders. |
| No. 2 | Government contract job. Ready-mixed concrete. No mix data available. Specified strength, 3000 psi; design strength, 3500 psi. |
| No. 3 | Building construction. Ready-mixed concrete. Slump—max 9.5 in., min 1.0 in., avg 5.4 in. No other mix data available. Two 6 by 12-in. cylinders molded from each of 105 batches. Strengths average of 28-day tests of each pair of cylinders. |
| No. 4 | Victor Talking Machine Co. Building, Camden, N. J. Job-mixed 1:2:4 concrete. Coarse aggregate—gravel; cement factor—6.0 sacks per cu yd; slump—max 10.0 in., min 4.0 in., avg 7.5 in. Three 6 by 12-in. cylinders molded from each of 63 batches during the period Apr. 25 to July 13, 1923. Strengths average of 28-day tests of each group of 3 cylinders. Mix and strength data from "Field Tests of Concrete Used on Construction Work" by W. A. Slater and Stanton Walker, *Proceedings*, Am. Soc. Civil Engrs., January, 1925. |
| No. 5 | Concrete floor slab, involving 42,500 cu yd of 1:2.05:3.17 concrete, job-mixed, using air-entraining cement. Coarse aggregate—1-in. slag; slump—max 5.5 in., min 1.0 in., avg 2.5 in. One 6 by 12-in. cylinder molded from each of 94 batches during the period Aug. 28 to Nov. 19, 1943; tested at 28 days. |
| No. 6 | Face of concrete dam with cement factor of 4.68 sacks per cu yd and slump less than 1 in. Concrete mixed 1 min in stationary 2-yd mixer. One 6 by 12-in. cylinder molded from each of 126 batches during the period 1940–1941; tested at 28 days. |
| No. 7 | Mass concrete for dam with cement factor of 3.72 sacks per cu yd and slump less than 1 in. Concrete mixed 1 min in stationary 2-yd mixer. One 6 by 12-in. cylinder molded from each of 98 batches during the period 1940–1941; tested at 28 days. |
| No. 8 | Housing project. Ready-mixed concrete. Coarse aggregate—1¼-in. gravel; cement factor—4.68 sacks per cu yd; slump—max 6.5 in., min 5.0 in., avg 6.0 in. One 6 by 12-in. cylinder molded from each of 31 batches during the period May 5 to Aug. 17, 1942; tested at 28 days. |
| No. 9 | Housing project. Ready-mixed concrete. Coarse aggregate—¾-in. gravel; cement factor—5.5 sacks per cu yd; slump—max 8.0 in, min 5.5 in., avg 6.2 in. One 6 by 12-in. cylinder molded from each of 82 batches during the period Aug. 24, 1942, to Aug. 30, 1943; tested at 28 days. |
| No. 10 | Airport construction. Job-mixed concrete. Coarse aggregate—1¼-in. slag; cement factor—6.0 sacks per cu yd; slump—max 7.0 in., min 0.8 in., avg 2.3 in. One 6 by 12-in. cylinder molded from each of 49 batches during the period Aug. 11 to Oct. 31 (year not indicated); tested at 28 days. |
| No. 11 | Housing project. Ready-mixed concrete. Coarse aggregate—1¼-in. gravel; slump—max 6 in., min 3.5 in. One 6 by 12-in. cylinder molded from each of 26 batches during the period Feb. 14 to Aug. 30, 1949; tested at 28 days. |
| No. 12 | Housing project. Ready-mixed concrete. Coarse aggregate—¾-in. gravel; slump—max 8 in., min 3 in. One 6 by 12-in. cylinder molded from each of 48 batches during the period May 17 to Sept. 1, 1949; tested at 28 days. |
| No. 13 | Housing project. Ready-mixed concrete. Coarse aggregate—¾-in. gravel; slump—max 6.5 in., min 3 in. One 6 by 12-in. cylinder molded from each of 40 batches during the period May 12, 1949, to Jan. 31, 1950; tested at 28 days. |
| No. 14 | Housing project. Ready-mixed concrete. Coarse aggregate—¾-in. gravel; slump—max 5 in., min 3 in. One 6 by 12-in. cylinder molded from each of 43 batches during the period Sept. 2, 1949, to Jan. 5, 1950; tested at 28 days. |
| No. 15 | Test data on pilot mixes. Coarse aggregate—¾ in.; slump—max 5.9 in., min 2.0 in. Cylinders molded during period Sept., 1949 to Mar., 1950. Strengths average of 2 cylinders tested at 28 days. No other data available. |
| No. 16 | Laboratory, 1:3 mix. Concrete mixed, cured, and tested under carefully controlled laboratory conditions. One 6 by 12-in. cylinder molded from each of 100 separate hand-mixed batches, moist cured at 70 F for 28 days and tested for compressive strength. |
| No. 17 | Laboratory, 1:4 mix. Concrete mixed, cured, and tested under carefully controlled laboratory conditions. One 6 by 12-in. cylinder molded from each of 100 separate hand-mixed batches, moist cured at 70 F for 28 days and tested for compressive strength. |
| No. 18 | Laboratory, 1:5 mix. Concrete mixed, cured, and tested under carefully controlled laboratory conditions. One 6 by 12-in. cylinder molded from each of 100 separate hand-mixed batches, moist cured at 70 F for 28 days and tested for compressive strength. |
| No. 19 | Laboratory, 1:7 mix. Concrete mixed, cured, and tested under carefully controlled laboratory conditions. One 6 by 12-in. cylinder molded from each of 100 separate hand-mixed batches, moist cured at 70 F for 28 days and tested for compressive strength. |
| No. 20 | Pilot mix series. Coarse aggregate—¾ in.; cement factor—4.37 sacks per cu yd; slump—max 7.2 in., min 3.0 in., avg 5.1 in. Design strength 2800 psi at 28 days. Mixed for 5 min. in a 2 cu ft S-tilting mixer. Two 6 by 12-in. cylinders molded from each of 79 batches during the period Sept., 1949, to Feb., 1950. Strengths average of 28-day tests of each pair of cylinders. |

tests made in the same laboratory on concretes of different richnesses (Nos. 16, 17, 18, and 19), the coefficients of variation increased as the concrete became leaner, but the standard deviation, expressed in pounds per square inch, remained essentially constant. This suggests the possibility that, for a given operation, the prediction of strength variations might be more accurately expressed in pounds per square inch than in per cent.

Data in Table IV indicate that the variability of strength tests cannot necessarily be considered constant even within a single operation. Strengths and coefficients of variation are shown for 10 large jobs furnished by the same company. Coefficients of variation ranged from a low of 11 per cent to a high of over 27 per cent. Factors which could have contributed to the differences are (1) season of the year, (2) cement shortages, resulting in the use of several brands on the same job, (3) variations in demand for concrete, resulting in reduced control of aggregate moisture during peak production, and (4) sampling and testing of the concrete by different agencies with varying degrees of conformance to standard methods.

Also of interest in Table IV is the fact that coefficients of variation for 28-day tests are consistently lower than for 7-day tests. The average difference was 3.5 percentage points. The greater variation for 7-day tests probably results from the fact that field test specimens are frequently not well protected and often are not transferred to the laboratory for moist curing until several days after fabrication. These deficiencies in early curing would contribute more to variation in the early strength than in the strength at later ages when differences between specimens have been partially equalized

TABLE IV.—REPRODUCIBILITY OF COMPRESSIVE STRENGTH TESTS FOR A SINGLE PRODUCER.

Data represent analyses of tests from 10 jobs for which concrete was furnished by the same producer.

| Job | Number of Tests[a] | Specified 28-Day Strength, psi | 7-Day Strength, psi | | | 28-Day Strength, psi | | | Coefficient Variation, per cent | | Per cent Failures[b] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | High | Low | Avg | High | Low | Avg | 7-day | 28-day | Actual | Theoretical |
| No. 1 | 11 | 2000 | 2130 | 850 | 1319 | 3500 | 1740 | 2583 | 27.4 | 21.8 | 18 | 15 |
| No. 2 | 30 | 2000 | 2330 | 1190 | 1745 | 4180 | 2540 | 3286 | 16.0 | 13.2 | 0 | 0.2 |
| No. 3 | 33 | 2000 | 1950 | 830 | 1490 | 3840 | 1610 | 2963 | 19.9 | 19.5 | 9 | 5 |
| No. 4 | 33 | 3000 | 2910 | 1460 | 2063 | 4740 | 2405 | 3395 | 17.8 | 16.3 | 18 | 24 |
| No. 5 | 12 | 2300 | 2920 | 1755 | 2271 | 4440 | 2900 | 3535 | 16.7 | 15.3 | 0 | 1 |
| No. 6 | 40 | 2300 | 2820 | 1285 | 1836 | 4385 | 2185 | 3132 | 22.8 | 16.6 | 2 | 5 |
| No. 7 | 16 | 3000 | 3640 | 1345 | 2488 | 5345 | 2530 | 3686 | 22.5 | 18.3 | 6 | 15 |
| No. 8 | 46 | 3000 | 3325 | 1170 | 2115 | 4350 | 2760 | 3419 | 18.5 | 11.0 | 6 | 13 |
| No. 9 | 100 | 3000 | 3450 | 1040 | 2320 | 5560 | 1960 | 3742 | 19.4 | 17.0 | 8 | 12 |
| No. 10 | 33 | 3000 | 3600 | 1940 | 2753 | 5690 | 3190 | 4313 | 18.0 | 15.0 | 0 | 2 |

[a] Averages of 2 cylinders each.
[b] 28-day strength below specified minimum.

by a reasonably long period of proper curing.

## Conclusion

In controlled tests of ready-mixed concrete, indications were that, where slump is maintained within usual tolerances, strength tests should reasonably be expected to have a coefficient of variation of about 10 per cent when deviations from standard testing procedures are not permitted. This figure allows for more-than-ordinary variations in mixing rate and time, size of batch and method of batching, which were purposely varied on this project. Variations in weather and in the strength-producing properties of the single brand of cement from shipment to shipment were probably about normal. The value of 10 per cent could not be considered to apply where more than one brand or type of cement was being used or where deviations from standard sampling and testing procedures were permitted. In actual field tests of ready-mixed concrete, under job conditions, coefficients of variation at 28 days were found to range from 7.0 to 21.8 per cent.

The data indicate that tests of single cylinders give strength values which approach in reproducibility tests consisting of averages of several cylinders (in this case, nine from each batch for each test age). It cannot be assumed that this would be true under the less favorable testing conditions that normally obtain in the field. Nevertheless, under conditions of proper supervision and interpretation of tests, single-cylinder results can be used to indicate strength level and uniformity. Because of the likelihood of securing occasional faulty or improperly treated specimens, single-cylinder results should not be used as a basis for acceptance or rejection of concrete unless proper allowance for low tests is made in the specification.

# A Laboratory Grinding Machine for Preparing Test Specimens from Rubber and Other Flexible Products*

By S. A. Eller and W. K. Gondek

In previous articles,[1,2] the constructional details and manner of operation of a laboratory grinding machine for preparing strip and cylindrical test specimens of rubber materials have been described. Comparatively little reference was made in these articles to the types of flexible materials that can be ground or to the products from which test specimens can be prepared. This article will answer the inquiries that have been received from Government and industrial laboratories regarding the applicability of the machine for grinding various types of flexible materials.

*The versatility of this grinding machine is demonstrated by preparing test specimens from end products, such as automobile tires and tubes, hose, electric cable, flooring materials, protective coatings, belting, and molded items.*

Essentially, the grinding machine conforms to the requirements of ASTM Method D 15.[3] It may be used to grind rough pieces of flexible materials into smooth, parallel surface strips from which tension test specimens conforming to the requirements of Federal Specification ZZ-R-601a[4] and ASTM Method D 412[5] can be prepared. The machine can also be adapted to grind accurately dimensioned cylindrical test specimens for stress relaxation tests.

Although the grinding machine and the procedures used to prepare strip and cylindrical specimens have been described previously, this information is repeated herein to present in one article all the pertinent information concerning the machine.

### Apparatus

As shown in Figs. 1 and 2, the grinding machine consists essentially of a machined base plate, *1*, on which is mounted a heavy-duty motor, *2*,

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* The opinions or assertions contained herein are the private ones of the authors and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

[1] C. K. Chatten, S. A. Eller, and W. K. Gondek, "A Machine for Use in Buffing Strip Samples of Rubber Materials," *Rubber Age*, Vol. 63, No. 6, September, 1948, p. 743.

[2] S. A. Eller, W. K. Gondek, and C. K. Chatten, "Laboratory Equipment for Buffing Rubber Specimens," ASTM Bulletin, No. 187, January, 1953, p. 53 (TP 7).

[3] Tentative Methods of Sample Preparation for Physical Testing of Rubber Products (D 15 – 52 T), 1952 Book of ASTM Standards, Part 6, p. 1.

[4] Federal Specification ZZ-R-601a—Rubber Goods; General Specifications (Methods of Physical Tests and Chemical Analyses).

[5] Tentative Method of Test for Tension Testing of Vulcanized Rubber (D 412 – 51 T), 1952 Book of ASTM Standards, Part 6, p. 132.

S. A. ELLER, Registered Professional Engineer of the State of New York, has since 1946 been in charge of the unit of the Rubber Development Section, New York Naval Shipyard, Brooklyn, that is responsible for carrying out development work on Navy specifications for rubber materials.

W. K. GONDEK, Rubber Technologist, New York Naval Shipyard, is in charge of the unit of the Rubber Development Section responsible for investigation work on coated gloves and approval evaluation of Navy rubber products.

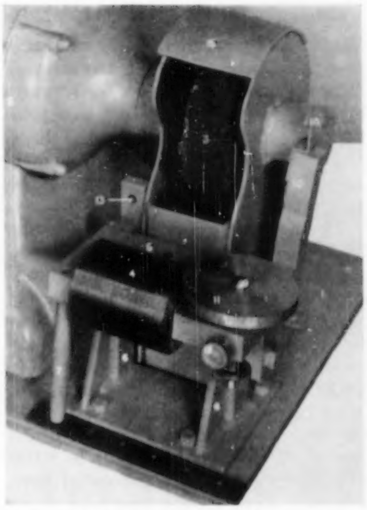


**Fig. 1.—Grinding Machine for Preparing Strip Specimens of Flexible Materials.**

equipped at both ends with grinding wheels, *3* (only one of which is shown in Figs. 1 and 2). Both wheels have an outside diameter of 5 in., a face width of 2 in., and a center hole for a $\frac{5}{8}$-in. arbor. One wheel is a fine grain type manufactured by the Carborundum Co. (type C100-L5-VG), and the other is a coarse grain wheel manufactured by the Norton Co. (type 37C36-K5V). Aligned to be parallel to each grinding wheel is a smooth surface, hollow brass roller, *4*. The grinding wheel and roller serve as abradant and backing, respectively, for the strip of flexible material (not shown in Figs. 1 and 2) which is ground between these parts. The roller *4*, is supported by and can rotate freely in sleeve bearings located in the upright sides of a U-shaped frame, *5*. This frame is hinged to a bracket, *6*, so that it can pivot between the two positions shown in Figs. 1 and 2 when lowered or raised by a handle, *7*. The parts are assembled so that the center line of the roller, *4*, is always at a lower elevation than that of the wheel, *3*. In addition, the frame, *5*, is designed to be inclined away from the wheel at all times, even when the wheel is worn to its minimum usable diameter of 4 in.

Threaded into the frame perpendicular to the center line of the roller is a thickness-adjusting screw, *8*. This screw is equipped with a hemispherical base, *9*, which contacts a rigid steel abutment, *10*, when the frame is pivoted to the position shown in Fig. 2. The metal-to-metal contact of the base, *9*, against the abutment, *10*, prevents further movement of the frame toward the wheel, and determines a minimum clearance space between these parts. This clearance space, which is the thickness to which the flexible strip will be ground, is thus controlled by the screw, *8*, and can be increased or decreased by advancing or retarding the screw in the frame. The screw has 20 threads per in. and is equipped with a calibrated dial, *11*, which has 50 divisions. Thus each division on the dial corresponds to a change of 0.001 in. in the minimum clearance space between wheel, *3*, and roller, *4*. The screw, *8*, is prevented from vibrating loose in the frame by set screw, *12*, which bears on a plastic insert to prevent damage to the threads of the screw. A safety stop, *13*, is positioned to keep the roller, *4*, from being ground by the wheel, *3*.

The minimum clearance space between wheel, *3*, and roller, *4*, is determined by the metal-to-metal contact of base, *9*, against abutment, *10*, and is thus independent of the force exerted on the handle, *7*. In addition, the abutment is equipped with an index marker, *14*, to position accurately the setting of the dial, *11*.

The wheel, *3*, is enclosed by the framework, *15*, which protects the machine operator from abraded particles. This framework is extended below the base plate, *1*, and is connected to a suction blower (not shown in Figs. 1 and 2). The air drawn into the suction blower is funneled by the framework to exert approximately equal pressure on the surfaces of the strip being ground and is of sufficient velocity to carry off abraded particles, fragments from the grinding wheel, and fumes resulting from the grinding process. These obnoxious materials are filtered to remove solid matter, and the remaining gases are exhausted to the outside atmosphere. A hinged door and wire mesh screen (not shown in Figs. 1 and 2) are located near the base of the framework, *15*, and serve to prevent passage to the suction blower of strips that may be pulled from the operator's hand.

The grinding machine can be operated to reduce the thickness of a strip up to 0.030 in. per pass between the wheel and the roller without causing undue heating of the strip, depending on the type of material, the percentage and nature of filler ingredients, and the roughness of the grinding wheel. The rough wheel of the machine is used for coarse grinding to remove comparatively large amounts of material per pass; and the fine grain wheel is used for finishing operations to obtain a smooth strip with a minimum of surface irregularities.

The grinding equipment in the Rubber Development Section of the Material Laboratory consists of three grinding machines, each made as described above, and all mounted on one work bench.

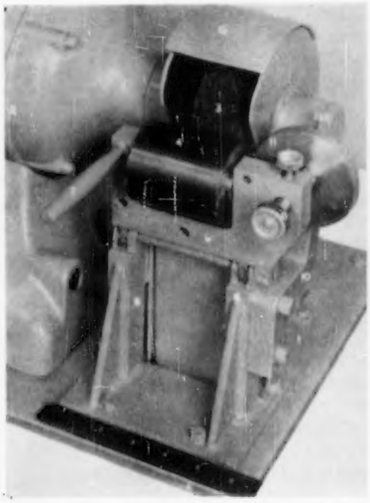


**Fig. 2.—Another View of the Grinding Machine for Preparing Strip Specimens of Flexible Materials.**

#### Procedure for Preparing Strip Specimens

The thickness-adjusting screw is positioned by the machine operator so that the minimum clearance space between the grinding wheel and the brass roller is slightly less than the thickness of the strip to be ground. Then, with one hand, the operator pivots the U-shaped frame to a position approximately midway between the positions shown in Figs. 1 and 2. The operator holds the frame in this position with one hand. He then permits the free end of a strip held in his other hand to fall into the enlarged clearance space between the wheel and the roller so that slightly more than half the surface of the strip to be ground is facing the wheel. He then advances the frame toward the wheel and just prior to contact of the strip with the wheel, he simultaneously starts to lift the strip at an angle of 60 ± 15 deg from the horizontal and inclined away from the wheel. The simultaneous operations of advancing the frame and lifting the strip are continued until the base of the screw contacts the abutment. When this occurs, the frame is held rigidly in this position while the remainder of the strip is ground by being lifted until it is clear of the wheel. He now turns the strip end for end and holding the ground end of the strip he proceeds to grind the other half of the surface as described above. There is an overlap in the grinding on each surface of the strip, and precautions are taken to keep the amount of overlap to a minimum. At the Laboratory, whenever possible, the overlap is located at a noncritical portion of a strip, such as at the tab ends of tension specimens. When one surface of the strip has been completely ground, the strip is turned

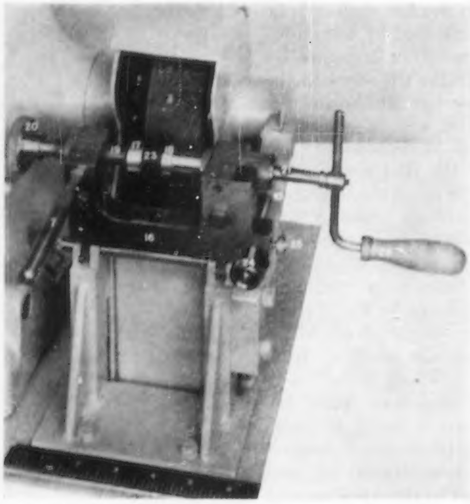


**Fig. 3.—Attachment on Grinding Machine for Preparing Cylindrical Specimens of Flexible Materials.**

over and the other surface ground as described above. After each surface of the strip is ground, the thickness-adjusting screw is reset to reduce the minimum clearance space between the wheel and the roller by an additional increment of thickness, measurable to 0.001 in. on the calibrated dial. The thickness of the ground strip is measured on a dial gage micrometer because thickness measurements using the calibrated dial require repositioning the dial every time the wheel is dressed.

When one surface of the strip is smooth and the other surface rough, the rough surface is ground first, the smooth surface bearing against the roller. Following this, both surfaces are ground alternately to obtain a strip of the desired thickness. When both surfaces of the strip are rough, first one and then the other rough surface is ground, gradually removing the irregularities from both surfaces until a smooth, parallel surface strip of the desired thickness is obtained. Smooth strips can be prepared from rough strips, since only those portions of the strip that are thicker than the setting of the minimum clearance space are ground. This occurs because the roller forces only the thick portions of the strip against the grinding wheel; the portions of the strip that are thinner than the setting of the minimum clearance space are not ground because the roller does not force these portions against the wheel.

When a large number of ground strips are required from similar materials, the strips can be prepared efficiently by grinding them consecutively at one setting of the thickness-adjusting screw prior to changing the setting.

Because of design considerations, such as the width of the grinding wheel, necessity for gripping the ends of the strips manually, etc., the maximum size strip that can be ground on the machine is 24 by $1\frac{1}{2}$ by $\frac{1}{2}$ in.; and the minimum size strip is 3 by $\frac{1}{8}$ by less than 0.010 in. Strips of flexible material having dimensions between those noted above can be ground to a tolerance of ±0.001 in. By exercising extreme care, strips of some elastomer materials 1 by 12 in. can be ground on the machine to a thickness of 0.004 ± 0.001 in.

### Preparation of Cylindrical Specimens

The machine can be adapted to grind accurately dimensioned cylindrical specimens of flexible material, such as those required for stress relaxation tests, by replacing the frame, *5*, shown in Figs. 1 and 2, by a similarly constructed U-shaped frame, *16*, shown in Fig. 3. This U-shaped frame is provided with a specimen-clamping device that consists of two disks, *17* and *18*. These disks are equal in outside diameter, which diameter is smaller than that of a finished cylindrical specimen. The disks are constructed to rotate freely with respect to frame, *16*, about an axis parallel to that of the grinding wheel, *3*. In addition, disk, *17*, is ball-bearing mounted on a screw, *19*, which is threaded in the upright side of the frame, so that disk *17* can be advanced toward or retarded from disk *18* by turning a knurled knob, *20*. The shaft, *21*, to which disk, *18*, is secured, is supported on ball-bearings located in the other upright side of the frame, and is restricted to rotary motion only when it is turned by the crank, *22*.

In operation, disk, *17*, is advanced longitudinally in order to friction-clamp the specimen, *23*, between the serrated faces of disks, *17*, and *18*. The arrangement of the apparatus is such that rotation of the crank, *22*, causes the disks, *17* and *18*, and the specimen, *23*, to rotate about an axis parallel to that of the grinding wheel, *3*.

The handle, *7*, is used to pivot the frame, *16*, and the above-mentioned appurtenances attached thereto, toward the wheel, *3*, to grind the periphery of the specimen, *23*. A diameter-adjustment screw, *24*, in threaded engagement with the frame, is positioned so that it contacts the abutment, *10*, when the specimen has been ground to the desired diameter, which for stress relaxation specimens is 1.129 ± 0.003 in. The screw, *24*, is prevented from vibrating loose in the frame by a set screw, *25*, which bears on a plastic insert (not shown in Fig. 3).

Because of design considerations, the machine can grind cylindrical specimens having maximum and minimum dimensions of $2\frac{1}{4}$-in. diameter by $1\frac{1}{2}$-in. thickness, and $\frac{3}{4}$-in. diameter by $\frac{1}{4}$-in. thickness, respectively. Specimens between these sizes can be ground to a desired diameter with a tolerance of ±0.003 in. measured over the entire ground periphery. The grinding machine can be used to prepare accurately machined, cylindrical specimens from flat surface pieces of flexible material which are multisided, elliptical, or circular in original contour.

### Procedure for Grinding Cylindrical Specimens

The unfinished specimen is centered manually while holding one surface in contact with one disk while the other disk is advanced longitudinally to friction clamp the specimen securely, but without excessive pressure, between the serrated surfaces of the disks. The crank is then rotated continuously at a slow rate of speed in the same direction of rotation as that of the grinding wheel. Simultaneously, the U-shaped frame is gradually pivoted upward about its support to feed the unfinished specimen into the grinding wheel. The operations of rotating and simultaneously feeding the specimen are continued until the diameter-adjustment screw contacts the abutment, thus preventing further reduction in the diameter of the specimen. As the specimen approaches the desired diameter, the pressure of the clamping disks on the specimen is reduced to minimize bulging. This is done because excessive clamping pressure bulges the center portion of the specimen and results in a finished specimen with concave sides.

The specimen must be rotated con-

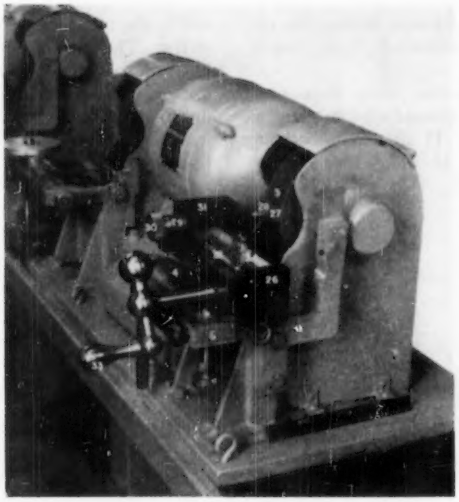



Fig. 4.—Device for Dressing Grinding Wheel.

tinuously as the grinding progresses to avoid flat spots on the periphery. In addition, the diameter of the specimen must be measured with a micrometer or other suitable device while the specimen is mounted in the machine. This is done because of the difficulty in re-centering the specimen once it is removed from the clamping disks.

### Diamond Dressing Device

The grinding wheel must be concentric with its drive shaft, free from adherent particles, and in parallel alignment with the axis of the U-shaped frame in order to grind accurately dimensioned strip and cylindrical specimens. Thus, it is necessary to dress the grinding wheel when a new wheel is inserted in the machine or when the grinding surface becomes grooved, chipped, eccentric, or clogged.

To minimize inaccuracies in the parallel alignment between the grinding wheel and the assembled U-shaped frame, a device was designed to dress the wheel with the roller assembly in place. This is accomplished by pivoting the U-shaped frame, *5*, and assembled roller, *4*, to the position shown in Fig. 1. Then a diamond dressing device, *26*, is bolted to the frame as shown in Fig. 4. The underside of the diamond dressing device is equipped with two steel alignment pins (not shown in Fig. 4), which fit into accurately aligned mating holes in the frame. These pins serve to position the device to dress the wheel, 3, in perfect parallel alignment to the roller, *4*.

The diamond dressing device consists essentially of a one-carat industrial diamond, *27*, mounted in a holder, *28*. A feed screw, *29*, to which the mounting, *28*, is secured, is equipped with a knurled knob, *30*, and is threaded into a slide block, *31*. The slide block, *31*, is in threaded engagement with a transverse screw, *32*. When a crank, *33*, is turned manually, the screw, *32*, is rotated by means of a linking bevel gear arrangement. Rotation of the screw causes the block, *31*, to move, guided by ways, *34*, longitudinally from end to end of the diamond dressing device, *26*, in parallel alignment with the roller, *4*. Thus, rotation of the crank, *33*, causes the diamond, *27*, to traverse the face of the wheel, *3*, thereby generating on the wheel a grinding surface that is concentric to its drive shaft, free from adherent particles, and parallel to the roller, *4*.

The device, *26*, is designed to permit the crank, *33*, to be turned in either direction, the direction of travel of the block, *31*, being automatically reversed at the ends of the transverse screw, *32*.

Since the dressing operation gradually reduces the size of the wheel, the grinding machine was designed to require replacement of the grinding wheel when it is worn to a diameter of 4 in. This was done because further wear of the grinding wheel would necessitate pivoting the U-shaped frame to the unsafe position where it is inclined downward toward the grinding wheel.

At the Material Laboratory all six U-shaped frames (on three machines) and the diamond dressing device were designed so that one device is capable of dressing all the grinding wheels in perfect parallel alignment with their respective brass rollers.

### Grinding Strip Samples from Flexible Materials and End Products

Samples of natural rubber, Buna S, neoprene, Buna N, butyl, silicone, thiokol, vinyl chloride, polyethylene, leather, and linoleum were acquired to investigate the suitability of the grinding machine for preparing smoothly ground, parallel surface strips from these different types of flexible materials. In addition, to demonstrate the practicability of the machine for preparing test specimens from end products which utilize flexible materials in their construction, representative samples of automobile tire components, hose products, electric cable, matting and flooring materials, protective coatings, conveyor belts, and molded products were also acquired.

TABLE I.—RESULTS OF TESTS OBTAINED ON FLEXIBLE MATERIALS USING SPECIMENS PREPARED ON THE GRINDING MACHINE.

| Type of Flexible Material | Hardness, Shore "A" | Tensile Strength, psi | Elongation, per cent | Thickness of Specimen, in. | Specific Gravity |
|---|---|---|---|---|---|
| Natural rubber | 33 | 2260 | 770 | 0.060 | 0.96 |
| Natural rubber | 74 | 3190 | 520 | 0.068 | 1.28 |
| Buna S | 43 | 1530 | 500 | 0.070 | 1.06 |
| Buna S | 66 | 2470 | 380 | 0.070 | 1.18 |
| Neoprene | 50 | 2050 | 780 | 0.069 | 1.28 |
| Neoprene | 79 | 2630 | 240 | 0.068 | 1.43 |
| Buna N | 42 | 1600 | 700 | 0.068 | 1.18 |
| Buna N | 80 | 1260 | 200 | 0.070 | 1.33 |
| Butyl | 64 | 1430 | 350 | 0.071 | 1.18 |
| Silicone | 39 | 570 | 320 | 0.069 | 1.16 |
| Silicone | 80 | 600 | 140 | 0.066 | 1.39 |
| Thiokol[a] | 46 | 430 | 510 | 0.070 | 1.41 |
| Thiokol | 59 | 1170 | 470 | 0.068 | 1.51 |
| Vinyl-Buna N | 95 | 2900 | 280 | 0.047 | 1.33 |
| Vinyl chloride | 59 | 1490 | 320 | 0.030 | 1.31 |
| Vinyl chloride | 95 | 810 | 30 | 0.067 | 1.73 |
| Polyethylene | 100 | 1290 | 180 | 0.070 | 0.92 |
| Leather[b, c] | 95 | 2620 | 17 | 0.065 | 1.14 |
| Linoleum[b, c] | 85 | 470 | 10 | 0.067 | 1.14 |

[a] Liquid polymer thiokol mixed with accelerator material and air cured only.
[b] Specimens tested at a jaw separation speed of 10 in. per min.
[c] Material from the strips being ground adhered to and clogged the abrasive surface of the grinding wheel. The adhered material was removed after the strips were ground by dressing the wheel. When contacted regarding the difficulty in grinding leather and linoleum materials, manufacturers of grinding wheels recommended the following wheels: For leather—Carborundum Co. type DA 36-G9-V20; Norton Co. type 32A24-H8V BE. For linoleum—Carborundum Co. type C36-L6-B8; Norton Co. type 37C24-J5V. The authors have no data regarding the suitability of the above wheels for grinding these materials.

Strips of flexible materials of sufficient size for grinding on the machine were removed from the above-mentioned materials. These strips were ground smooth on the machine, operated as described above, to a thickness of approximately 0.070 in. or to the maximum possible thickness obtainable on thinner strips removed from some products.

Tension specimens were then prepared from the ground strips using a type C or type D die described in ASTM Method D 412,[5] the smaller width die being used for narrow width strips. The tension specimens were then plied up to a thickness of approximately ¼ in., and the instantaneous Shore "A" durometer hardness of the materials was determined. Following this, the thickness of each specimen was meas-

**Fig. 5.—Automobile Tire Components.**

**Fig. 6.—Flexible Hose Products.**

TABLE II.—RESULTS OF TESTS OBTAINED ON FLEXIBLE MATERIALS REMOVED FROM END PRODUCTS, USING SPECIMENS PREPARED ON THE GRINDING MACHINE.

| Item | Figure No. | End Product | Location of Specimen | Type of Flexible Material | Hardness, Shore "A" | Tensile Strength, psi | Elongation, per cent | Thickness,[a] in. | Specific Gravity |
|---|---|---|---|---|---|---|---|---|---|
| *A* ... | 5 | Automobile tire | Tread stock | Natural rubber | 60 | 1490 | 320 | 0.073 | 1.09 |
| *B* ... | 5 | Automobile tire boot | ... | Butyl | 64 | 1430 | 350 | 0.071 | 1.18 |
| *C* ... | 5 | Automobile inner tube | ... | Buna S | 60 | 1330 | 430 | 0.066 | 1.17 |
| *D* ... | 6 | Oil suction-and-discharge hose | Cover | Neoprene | 70 | 1540 | 260 | 0.068 | 1.42 |
| | | | Tube | Neoprene | 70 | 1420 | 260 | 0.069 | 1.43 |
| *E* ... | 6 | Fire hose, neoprene covered | Cover | Neoprene | 70 | 1650 | 260 | 0.040 | 1.41 |
| | | | Tube | Natural rubber | 58 | 1840 | 420 | 0.050 | 1.24 |
| *F* ... | 6 | Oxygen-acetylene hose | Cover | Natural rubber | 46 | 2890 | 600 | 0.033 | 1.18 |
| | | | Tube | Neoprene | 65 | 1550 | 230 | 0.075 | 1.52 |
| *G* ... | 6 | Steam hose, wire reinforced | Cover | Natural rubber | 57 | 1660 | 430 | 0.061 | 1.42 |
| | | | Tube | Natural rubber | 56 | 2130 | 450 | 0.067 | 1.42 |
| *H* ... | 6 | Fire hose, cotton jacketed | Tube | Natural rubber | 49 | 1570 | 440 | 0.037 | 1.14 |
| *I* ... | 6 | Fuel oil hose | Cover | Neoprene | 55 | 990 | 610 | 0.030 | 1.49 |
| | | | Tube | Buna N | 56 | 1770 | 230 | 0.072 | 1.28 |
| *J* ... | 6 | Grease lubricating hose | Cover | Neoprene | 60 | 900 | 320 | 0.031 | 1.52 |
| | | | Tube | Neoprene | 60 | 960 | 160 | 0.053 | 1.48 |
| *K* ... | 7 | Electric cable, armored | ... | Neoprene | 64 | 1830 | 390 | 0.064 | 1.46 |
| *L* ... | 7 | Electric cable, multistrand | Outer cover | Neoprene | 55 | 1810 | 430 | 0.069 | 1.54 |
| | | | Inner cover | Natural rubber | 53 | 1260 | 680 | 0.048 | 1.42 |
| *M* ... | 7 | Electric cable, armored, experimental | ... | Vinyl chloride and Buna N | 95 | 2900 | 280 | 0.047 | 1.33 |
| *N* ... | 7 | Electric cable, 3-conductor | ... | Vinyl chloride | 81 | 1610 | 400 | 0.034 | 1.23 |
| *O* ... | 7 | Electric cable, 4-conductor, portable | ... | Vinyl chloride | 59 | 1490 | 320 | 0.030 | 1.31 |
| *P* ... | 7 | Electric cable, 2-conductor, portable | ... | Vinyl chloride | 80 | 1060 | 260 | 0.018 | 1.38 |
| *Q* ... | 8 | Matting, ribbed | ... | Neoprene | 65 | 1730 | 670 | 0.030 | 1.70 |
| *R* ... | 8 | Matting, pyramid design | ... | Buna N | 74 | 940 | 230 | 0.051 | 1.46 |
| *S* ... | 8 | Linoleum, battleship[b,c] | ... | Linoleum | 85 | 470 | 10 | 0.067 | 1.14 |
| *T* ... | 8 | Flooring, vinyl | ... | Vinyl chloride | 95 | 810 | 30 | 0.067 | 1.73 |
| *U* ... | 9 | Propeller shaft covering, cold bond | ... | Neoprene | 60 | 1950 | 440 | 0.067 | 1.46 |
| *V* ... | 9 | Propeller shaft covering, brushed-on | ... | Neoprene | 70 | 1230 | 340 | 0.052 | 1.54 |
| *W* ... | 9 | Propeller shaft bearing, water lubricated | ... | Buna S | 74 | 2280 | 220 | 0.072 | 1.18 |
| *X* ... | 9 | Lining, protective tank | ... | Buna N | 64 | 2290 | 620 | 0.073 | 1.24 |
| *Y* ... | 10 | Gasket material, cloth inserted | ... | Neoprene | 59 | 1910 | 740 | 0.028 | 1.43 |
| *Z* ... | 10 | Belt, leather[b,c] | ... | Leather | 90 | 1810 | 15 | 0.069 | 1.09 |
| *BA* ... | 10 | Molded pump piston | ... | Buna N | 66 | 2470 | 380 | 0.070 | 1.18 |
| *BB* ... | 10 | Conveyor belt, cotton duck reinforced | Top layer | Neoprene | 70 | 1510 | 390 | 0.066 | 1.42 |
| | | | Bottom layer | Neoprene | 70 | 1450 | 370 | 0.049 | 1.42 |
| *BC* ... | 10 | Conveyor belt, glass fabric reinforced | Top layer | Buna S | 56 | 3060 | 560 | 0.070 | 1.14 |
| | | | Bottom layer | Buna S | 55 | 2780 | 580 | 0.041 | 1.17 |
| *BD* ... | 10 | Molded pump piston | ... | Neoprene | 72 | 2120 | 210 | 0.070 | 1.31 |

[a] Thickness of specimen tested.
[b] Specimen tested at a jaw separation speed of 10 in. per min.
[c] As indicated in footnote *c* of Table I, material from the strips being ground adhered to and clogged the abrasive surface of the grinding wheel.

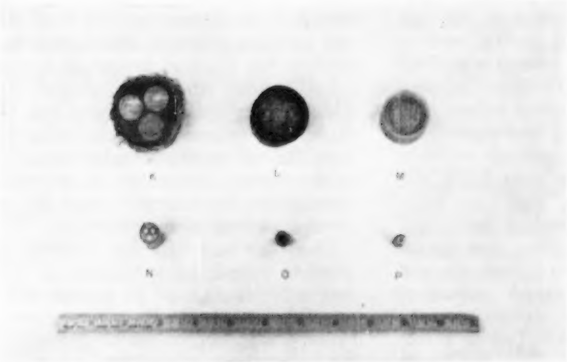


Fig. 7.—Flexible Electric Cable.

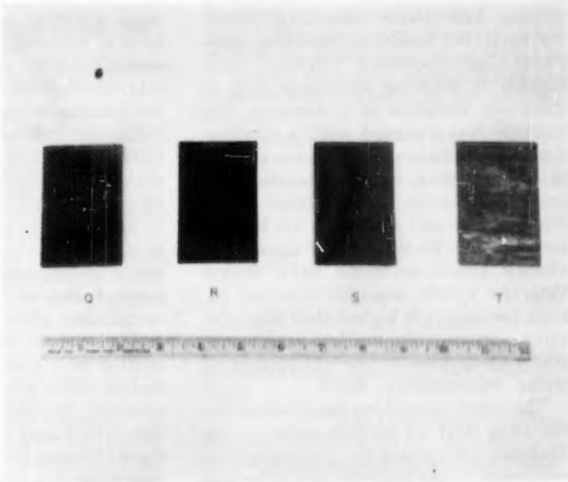



Fig. 8.—Matting and Floor Materials.


Fig. 9.—Flexible Protective Coatings.

Fig. 10.—Conveyor Belts and Molded Products.

ured to the nearest 0.001 in. with a dial gage micrometer.

After conditioning the prepared specimens for at least two days at room temperature, the tensile strength and elongation were determined on a Scott tension machine operated in accordance with the procedures described in Federal Specification ZZ-R-601a.[4] The jaw separation speed was 20 in. per min for all specimens except for the leather and linoleum specimens, which were tested at 10 in. per min. In addition, the materials were subjected to chemical analysis to determine the basic ingredient and the specific gravity.

The results obtained on the softest and hardest sample of each type of flexible material, when there was more than one hardness of that type of material available, are tabulated in Table I. The data include the following: type of flexible material, hardness, tensile strength, elongation, thickness of specimen, and specific gravity.

The types of end products used in this investigation are shown in Figs. 5 to 10, inclusive, and are identified in Table II. In addition, the data in Table II include the location on the end product from which the specimens were obtained, the type of flexible material, the hardness, the tensile strength, the elongation, the thickness, and the specific gravity of the materials tested.

Cross-section views of the representative types of end products included in this investigation are shown in Figs. 5 through 10, under categories of automobile tire components, flexible hose products, flexible electric cable, matting and flooring materials, flexible protective coatings, and conveyor belts and molded products, respectively. In the photographs the end products are identified by item letters.

The numerical values of the physical properties of the flexible materials tabulated in Tables I and II should not be assumed to be those normally expected for the materials. These representative types of materials were selected by the authors, without prior information as to their age, conditioning, or state of cure, to illustrate the variety and complexity of end products from which standard test specimens can be prepared on the grinding machine. Since the authors have no information regarding special design considerations which may have influenced the selection of flexible materials in the end products, the types of elastomeric materials found herein should not be regarded as those normally recommended for the products. For example, the automobile tire boot was compounded from butyl, whereas Buna S would normally be used; and the automobile inner tube was compounded from Buna S, whereas butyl is considered to be more satisfactory for this purpose.

### Conclusions

The grinding machine described herein is a high-speed, semiautomatic device for grinding rubber and other flexible materials into accurately dimensioned strip and cylindrical speci-

mens suitable for use in conducting tension and stress relaxation tests. To keep the machine operating constantly at maximum efficiency and capable of grinding specimens with a minimum variation in dimensions, the machine was designed with a dressing device to maintain the abrasive surface of the grinding wheel constantly in parallel alignment with the other parts. Smoothly ground specimens are recommended for tension tests, since previously conducted tests have shown that the tensile strength obtained on such specimens is higher than that obtained on roughly finished specimens, probably because of the elimination of stress concentration flaws.

The grinding machine described above has been used for several years by the Material Laboratory for preparing test specimens from a wide variety of flexible end products that the Navy uses. During these years the machine has experienced a gradual evolution of improvements, each improvement being subjected to practical day-to-day usage before being incorporated in the permanent design of the machine.

Because the strips are held manually while being ground in the machine, lost motion, such as would be encountered in clamping and unclamping the strips in a holder, is eliminated. Manual manipulation of the strip also permits the machine operator to select optimum grinding conditions to suit the type of material being ground, such as maximum depth of cut per pass and the rate at which the strip is pulled between the grinding wheel and the roller.

The authors believe that elastomeric materials should be ground on both surfaces to eliminate mold finish and surface irregularities prior to being tested. Insofar as product evaluation is concerned, they believe that elastomeric material removed from the end product should be tested instead of specimens prepared from specially molded tensile sheets. Tensile sheets molded in a uniform shape and cross-section under ideal curing conditions of pressure, temperature, and time give data which may not be consistent with those obtained from end products. The reason for this is that end products are frequently of irregular shape and cross-section making it virtually impossible to predict accurately the conditions under which the elastomeric portions of end products are being cured.

The grinding machine described above permits the preparation of accurately machined test specimens from a wide variety of end products. This innovation is advantageous since it permits a manufacturer to analyze the efficiency of his manufacturing operations and to exercise quality control on his products. From a consumer's viewpoint, the testing of specimens removed from the end product provides information regarding the physical properties of the actual product offered for delivery. In addition, product development can be expedited, because specimens prepared from the end product can be subjected to short-term, accelerated aging conditions in the laboratory, instead of depending on long-term service tests.

The time and expense involved in grinding cylindrical specimens are excessive for those used for routine compression set tests. However, ground cylindrical specimens are recommended for use in stress relaxation tests, where accurately dimensioned, cylindrical specimens are required.

*Acknowledgment:*

The authors gratefully acknowledge the assistance of W. E. Scoville, Jr., of the U. S. Rubber Co. for furnishing many of the samples, and to J. F. Schuster, P. E. Holmes, N. J. Giardina, J. J. Mahon, and E. A. Garde of the Material Laboratory for identifying and testing the numerous samples.

Thanks are also due to C. K. Chatten, Head of Rubber Development Section, Material Laboratory, New York Naval Shipyard, for his encouragement and beneficial suggestions in the preparation of this article.

## Effect of Soils on Asbestos-Cement Pipe

Field studies of the effect of soil exposure on properties of asbestos-cement pipe have been completed at the National Bureau of Standards as part of a long-range program to determine the effects of various soils on materials for underground construction.

Two sizes of pipe, 4 in. and 6 in. in diameter, designed to withstand 150 psi pressure, were used in the study. Both sizes were fabricated from a thin slurry of portland cement and asbestos fibers, but there were minor differences in the technique used to transfer the slurry to the mandrel on which the pipe was formed. After removal from the mandrel, the 6-in. pipe was cured by a high-pressure steam process while the 4-in. pipe was cured by submersion in water two to three weeks.

Specimens of the 6-in pipe were removed from the 15 exposure sites after periods of 2, 4, 9, 11, and 13 years; 4-in. specimens at the end of 2, 7, 9, 11, and 13 years. They were then subjected to measurements of hydrostatic bursting strength, crushing strength, water absorption, apparent specific gravity, and condition of the surface of the specimens. Representative specimens of unexposed pipe of both types were also subjected to the same tests, to supply reference data in determining the effects of the various soils and periods of exposure on the pipe materials.

Saturation with water reduces the strength of asbestos-cement pipe from 10 to 20 per cent. Thus, in order to simulate service conditions the 6-in. specimens were immersed in water for 48 hr before bursting and crushing testing. The 4-in. specimens were tested in the air-dry condition and then adjusted to the water-saturated condition by reducing the values for tensile strength and modulus of rupture by 15 per cent.

Surface condition of the specimens was determined semiquantitatively by scratching the external surface and, more objectively, by grinding under carefully controlled conditions until the measured hardness was equal to that of the unexposed reference pipe. The thickness of the removed layer was then taken as a measure of the softening of the surface.

In general, the data show an increase in strength during the early periods of exposure followed by a decrease in strength during the latter periods. The increased strength, which is generally accompanied by a decrease in water absorption, is associated with a curing process that continues for several years during exposure to the soil. After completion of the curing process, the specimens began to show the effects of weathering, as manifested by loss of strength, decrease in apparent specific gravity, increased absorption of water, and superficial softening.

Averages of the strength and water-absorption measurements indicated that the curing period was two to four years in the 6-in. pipe, as compared with approximately seven years in the 4-in. pipe. This longer curing period may be due to different initial curing processes, dimensions, composition, and methods of fabrication. Weathering also proceeded more rapidly in the larger than in the smaller pipe.

Alteration of the specimens was affected by soil conditions, weathering by organic and inorganic acidity.

The average tensile strength of the 6-in. pipe after 13 years' exposure was of the same order of magnitude as that of unexposed pipe, and that of the 4-in. pipe was higher. Even under the most adverse conditions the bursting and crushing strengths of all the specimens after exposure were higher than the requirements of the Federal Specifications for asbestos-cement pipe.

*Books . . .*

*(Continued from page 46)*

ments with the Solid State Devices Division of Battelle Memorial Inst. to organize and abstract these papers for publication.

These abstracts will be of considerable use not only to researchers working in this interesting new field but also to engineers whose aim is the reduction to engineering practice of some of the scientific findings.

• • •

### Control of Emissions from Metal Melting Operation

**American Foundrymen's Society, Des Plaines, Ill., $2.25.**

Information contained in this pamphlet will provide foundry management with a guide to control of air pollution. It describes the engineering characteristics of the various types of equipment now in actual service for controlling emissions from metal-melting operations and includes typical operating data.

Practical illustrations, tables, and an extensive bibliography add to the value of this booklet.

• • •

### Cellulose and Cellulose Derivatives, Parts I and II

**Interscience Publishers, Inc., New York, N. Y., $12 each**

Part I develops in great detail the occurrence, chemical nature, and properties of natural cellulose. Part II discusses the preparation of cellulose from its natural sources, bleaching and purification of wood cellulose, properties and treatment of pulp for paper, and expands upon the many derivatives of cellulose. This work has been greatly improved over the original 1943 edition, and would prove a very worth while addition to any cellulose library.

ASTM members who contributed to this work are: J. H. Elliott, Hercules Powder Co., Leo B. Genung, Eastman Kodak Co., R. S. Hatch, Hudson Pulp & Paper Corp., Emil Kline, Industrial Rayon Corp., E. D. Klug, Hercules Powder Co., H. Mark, Polytechnic Institute of Brooklyn, A. F. Martin, Hercules Powder Co., L. F. McBurney, Hercules Powder Co., and Kyle Ward, Jr., The Institute of Paper Chemistry.

• • •

The 1953 supplement to the **Preliminary Bibliography of Housing and Building in Hot-Humid and Hot-Dry Climates** has been issued by the Bureau of Engineering Research of the University of Texas at $1 a copy.

This first annual supplement provides a continuing bibliography of recent literature on this subject to supplement the original edition of 1952. It contains 750 entries, many with abstracts.

### ACI Manual of Concrete Inspection

**American Concrete Inst., 18263 W. McNichols Rd., Detroit 19, Mich; $2.50**

The American Concrete Institute has now published the third edition of the ACI Manual of Concrete Inspection. This manual provides an excellent guide and reference for the engineer, architect, and contractor interested in the use of concrete in all types of construction. It places in the hands of the inspector a concise source of information. As stressed in the introduction, the best of materials and design practice would not be effective unless the construction were well performed. Competent inspection is a very important part of the operation.

This manual describes methods of inspecting concrete construction generally accepted as good practice and intended as a supplement to specifications. The various sections include control of proportions, inspection and testing of materials, inspection of the concrete operation both before, during, and after placement, and means of compiling records and reports. In addition, there is a very comprehensive list of references and a list of standard specifications and test methods, most of which are ASTM standards.

The Manual was prepared by the ACI Committee 611 on Inspection of Concrete, J. W. Kelly, chairman.

• • •

### Safe Practices for Inert-Gas Metal-Arc Welding

**American Welding Society, 33 West 39th St., New York 18, New York; 50 cents**

The first and only publication covering all aspects of safety involved in the use of inert-gas metal-arc welding has just been published by the American Welding Society. By following the simple control measures recommended in this standard, safe working conditions can be assured.

The report, titled "Recommended Safe Practices for Inert-Gas Metal-Arc Welding," represents the findings of a special subcommittee of the AWS Committee on Safety Recommendations, and is based on laboratory studies, the experience of industry to date, and an extensive review of the literature and industrial records.

All known potential hazards peculiar to the inert-gas metal-arc process are covered in the report. The findings of the committee, comprising both medical and technical men, showed that no significant hazards exist from either ozone or nitrogen oxide, and, contrary to some early reports, that there is no dangerous amount of radioactivity given off by thoriated-tungsten electrodes.

However, the report focuses attention on the hazard of trichloroethylene when used in the vicinity of inert arc welding. Decomposition of trichloroethylene vapor by radiation from the welding arc produces noxious fumes including phosgene. Therefore, this chemical, often used in degreasing operations, should be so located that even minute quantities of vapor will not come in contact with the welding arc.

The pamphlet also outlines adequate control measures for protecting workers from ultraviolet radiation and metal fumes produced in inert-gas metal-arc welding.

• • •

### Fiberglas Reinforced Plastics

**Ralph H. Sonneborn and others, Reinhold Publishing Corp., New York, 1954, 240 pp., $4.50.**

This book probably offers the first complete treatment ever published on the subject of reinforced plastics, the amazing postwar structural material that has found its way into scores of new industries and products.

Written for both design engineers and executives in the materials industries, the book covers in full detail the resins and glass reinforcements used in reinforced plastics, molding techniques, inspection and testing properties, and design consideration.

Of special interest are two chapters contributed by leading authorities in engineering research. The first, written by Prof. A. G. H. Dietz, Head of the Department of Structural Materials at MIT, discusses the theory and fundamental concepts of reinforced plastics. The second, prepared by A. S. Heyser of Reed Research, Inc., deals with design from the viewpoint of the structural engineer.

Publication of this important book will provide all those concerned with reinforced plastics—molders, materials suppliers, Government agencies, engineers—with a wealth of information never before available in a single volume.

• • •

### 1954 Modern Packaging Encyclopedia

The latest edition of this Encyclopedia issue features eight new sections not previously treated separately. This edition has been revised and expanded to include several charts which will be of assistance in planning a packaging program. The planning and evaluation of any packaging program, however, places great reliance on information gained from test methods. A section devoted to standard test methods and apparatus would certainly increase the utility of this Encyclopedia.

Among those who have contributed to the Encyclopedia are: W. B. Lincoln, W. C. Walker, and A. C. Zettlemoyer, who have been prominent in developing ASTM standards in these fields.

Modern Packaging Corp., Emmett St., Bristol, Conn., 755 pp.

# PROFESSIONAL CARDS

**Commercial Testing and Research:**

- Chemical
- Metallurgical
- Physical
- Radiographic
- Spectrographic
- Sampling

# PROFESSIONAL CARDS

Below and on previous page are announcements by leading organizations and individuals of their services.

# PERSONALS...

**News items concerning the activities of our members will be welcomed for inclusion in this column.**

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

The following men active in ASTM were honored at the spring meeting of the American Chemical Society in Cleveland, Ohio, by presentation of 50-year membership certificates: **William M. Barr,** retired Union Pacific Railroad Co. Chief Engineer, and Research and Standards Consultant (ASTM Past-President); **Frederic Bonnet, Jr.,** retired Director of Standards Department, American Viscose Co., and 1952 recipient of ASTM Harold DeWitt Smith Memorial Medal; **Harry E. Jordan,** Executive Secretary of the American Water Works Assn.; and **Paul F. Wehmer,** Chemist, Electrical Testing Laboratories, New York City.

At the 11th Annual Conference of the National Association of Corrosion Engineers in Chicago in March, **F. L. Whitney, Jr.,** Corrosion Consultant, Monsanto Chemical Co., St. Louis, Mo., and **W. F. Fair, Jr.,** of the Tar Products Division of Koppers Co., Inc., Westfield, N. J., were elected President and Vice-President respectively. **Arthur W. Tracy,** Assistant Metallurgist, The American Brass Co., Waterbury, Conn., was named chairman of the Editorial Review Subcommittee of the NACE Publications Committee.

**Gerard A. Albert,** formerly Staff Manager, has been named Manager of Manufacturing, National Vulcanized Fibre Co., Wilmington, Del.

**E. L. Baldeschwieler** recently retired as Section Head, Products Research Division, Esso Research and Engineering Co., Linden, N. J. Very active for many years in the work of Committee D-2 on Petroleum Products and Lubricants, especially in its Research Divisions III on Elemental Analysis, and IV on Hydrocarbon Analysis, Mr. Baldeschwieler has been made an honorary member of Research Division III.

**Fred B. Behrens,** formerly with the Wilshire Oil Co., Inc., Norwalk, Calif., is now Assistant to the Vice-President, Richfield Oil Corp., Los Angeles, Calif.

**E. P. Best** has been appointed Chief Metallurgist at A. M. Byers Co.'s Ambridge (Pa.) plant, succeeding **E. B. Story,** recently retired. Mr. Story is being retained by the company in a consulting capacity.

**James E. Booge,** Chemical Director, Pigments Dept., E. I. du Pont de Nemours & Co., Newport, Del., retired April 30. **Lombard Squires,** Director of the Technical Division of the Atomic Energy Division of the company's Explosives Department, has been appointed his successor. Associated with du Pont since 1917, Dr. Booge became Chemical Director of the Pigments Department in 1946. During his tenure as Director, the Pigments Department developed the first commercial process for making ductile titanium metal, and significant advances also were made in the development of new and improved pigments.

**Arthur B. Bronwell** recently resigned as Executive Secretary of the American Society for Engineering Education to become President of Worcester Polytechnic Inst., Worcester, Mass.

(*Continued on page 82*)

(Continued from page 80)

**Kenneth R. Brown,** Vice-President, Atlas Powder Co., Wilmington, Del., received the 1955 honor award of the Commercial Chemical Development Assn. at a dinner at the Hotel Statler New York City, March 17. The award, presented annually for outstanding achievement in the field of commercial chemical development, was given to Mr. Brown for pioneering work in the development and marketing of sorbitol and related products.

**Alfred Candelise** has been advanced to Experimental Engineer in Charge of Spark Plugs, AC Spark Plug Division, General Motors Corp., Flint, Mich.

**Farrington Daniels,** of the University of Wisconsin, is 1955 recipient of the Willard Gibbs Medal of the Chicago Section of the American Chemical Society. Professor Daniels recently returned from the UNESCO Conference on Wind and Solar Energy at New Delhi, India.

**F. J. DeWitt,** formerly Vice-President of the Parker Rust Proof Co., Detroit, Mich., is now President of the Tropical Paint Co., wholly owned subsidiary of Parker Rust Proof in Cleveland, Ohio.

**Robert Newell DuPuis,** Director of Research and Development at Philip Morris & Co., Richmond, Va., has been elevated to the newly created position of Vice-President in Charge of Research.

**Junius D. Edwards** has retired as Director of Research, Aluminum Company of America, Pittsburgh, Pa. Representing his company since 1936 on ASTM Committee B-7 on Light Metals and Alloys, Mr. Edwards made valued contributions to the work of this committee, serving on a number of subgroups, and for many years heading the activities of Subcommittee VI on Anodic Oxidation of Aluminum and Magnesium Alloys.

**Giles E. Hopkins,** Technical Director, The Wool Bureau, Inc., New York City, since the Bureau's founding, has resigned. He is succeeded by **Gerald Laxer,** recipient of a 1951 Wool Bureau Fellowship for study at Leeds University. Before joining the Wool Bureau Mr. Hopkins was associated for 12 years with the Bigelow-Sanford Carpet Co., and previously with the Textile Research Inst. He will announce his future plans at a later date. In ASTM he has long been active in Committee D-13 on Textile Materials, particularly in the organizational work relative to the wool activities of this group.

**C. M. Houck** is now Chairman of the Board, Pittsburgh Testing Laboratory, Pittsburgh, Pa.

**Valens Jones,** formerly Research Engineer with the U. S. Bureau of Reclamation, is now associated with The Master Builders Co., Denver, Colo.

**Paul E. LaValley** has accepted a position with A. L. Smith Iron Co., Chelsea, Mass., as Chemical Engineer.

**Vincent E. Lysaght** has been appointed General Sales Manager of the American Chain and Cable Co., Inc., New York City. He will continue to manage the Wilson Mechanical Instrument Division of ACCO, manufacturers of the well-known Rockwell Hardness Tester. Representing his company for many years in ASTM, Mr. Lysaght serves on a number of the technical committees.

**James P. A. McCoy** recently retired as Chemical Engineer, Allis-Chalmers Manufacturing Co., Milwaukee, Wis. He has opened offices as consulting chemical engineer at 2664 N. Hackett Ave., Milwaukee.

**Robert C. McMaster,** formerly Supervisor, Electrical Engineering Div., Battelle Memorial Inst., is now on the faculty of Ohio State University as Professor of Welding Engineering.

**William Wallace Mein, Jr.,** President of Calaveras Cement Co. and Bishop Oil Co., both of San Francisco, Calif., has been elected Vice-President of the American Institute of Mining, Metallurgical and Petroleum Engineers. Representing the mining branch of the Institute, he will serve for a three-year term ending in the spring of 1958. Mr. Mein has been active

(Continued on page 84)

(*Continued from page 82*)

in the AIME since 1936. In 1949 he headed the arrangements committee for the organization's national meeting in San Francisco.

**Benjamin S. Mesick,** former Commanding Officer of Watertown Arsenal, Watertown, Mass., recently joined the staff of Arthur D. Little, Inc., industrial research and consulting firm of Cambridge, Mass. As a senior staff member, his chief responsibility will be to expand the company's activities in the titanium fabrication field and to explore the numerous industrial uses for this metal.

**Frank W. Reinhart,** Chief of the Organic Plastics Section of the National Bureau of Standards, Washington, D. C., was elected President of the Society of Plastic Engineers during their January convention held in Atlantic City, N. J. He is the past National Secretary of SPE, and on the SPE National Board of Directors of the Baltimore-Washington Section. In ASTM, Mr. Reinhart is a member and past-chairman of Committee D-14 on Adhesives and currently is serving as a Vice-Chairman of Committee D-20 on Plastics.

**Fraser B. Rhodes,** until recently Ceramist with The John Douglas Co., subsidiary of Briggs Manufacturing Co., is now Chief Ceramist with Briggs Manufacturing in Cincinnati, Ohio.

**George A. Round,** for many years Chief Automotive Engineer, Socony-Vacuum Oil Co., Inc., New York City, retired a few months ago. Affiliated with ASTM for a number of years, Mr. Round also has been active in the work of the Society of Automotive Engineers and the American Petroleum Inst. He is now technical consultant for the API Lubrication Committee. Mr. Round may be addressed at North Haven, Sag Harbor, N. Y.

**Robert A. Saxer,** formerly Senior Metallurgist, Hamilton-Standard Div., United Aircraft Corp., Windsor Locks, Conn., is now associated with the Republic Steel Corp., Cleveland, Ohio, as Process Metallurgist.

**Karl Schwartzwalder,** Director of Research, AC Spark Plug Division, General Motors Corp., Flint, Mich., is President-elect of the American Ceramic Society for 1955–56.

**Evan M. Shay,** Chief Laboratory and Field Engineer, O. J. Porter and Co., Los Angeles, Calif., is now Soils and Foundation Engineer, Knappen, Tippetts, Abbett, McCarthy Engineers, in Adana, Turkey.

**Norman H. Spear,** formerly with Colt's Manufacturing Co., is now Research Physicist, Emhart Manufacturing Co., Hartford, Conn.

**Carl F. Speh,** Assistant Director of Utilization Research for United States Department of Agriculture, and well known as leading authority on Naval Stores, recently retired. Mr. Speh was for many years a member of ASTM Committee D-17 on Naval Stores.

**G. F. A. Stutz** has been appointed Manager of Pigment Division, The New Jersey Zinc Sales Co., New York City and Palmerton (Pa.). Mr. Stutz, who recently had been promoted to Manager of Technical Service, will continue to supervise the activities of that unit.

**Robert L. Terrill** has been named Manager, Industrial Products Research, Spencer Kellogg and Sons, Inc., Buffalo, N. Y. Until recently he had been assistant to Dr. Alexander Schwarcman, Vice-President. In his new position Mr. Terrill will be concerned chiefly with new products for the paint industry, directing research on new materials for printing inks, paper coatings, and adhesives. According to **M. M. Renfrew,** Director of Research and Development, Mr. Terrill's appointment is part of an expanded research pro-

(*Continued on page 85*)

gram which will be carried out in the new laboratory now under construction near the Buffalo airport. Mr. Terrill has been active for some time in the work of ASTM Committee D-1 on Paint, Varnish, Lacquer, and Related Products.

**William J. Troeller, Jr.** has been appointed a Section Head, Products Research Div., Esso Research and Engineering Co., Linden, N. J., succeeding **E. L. Baldeschwieler,** recently retired. Mr. Troeller has been serving on Research Division III on Elemental Analysis of ASTM Committee D-2 on Petroleum Products and Lubricants, and has been named to replace Mr. Baldeschwieler on Research Division IV on Hydrocarbon Analysis.

**Clair Upthegrove** has been named Professor Emeritus of Metallurgical Engineering at the University of Michigan, Ann Arbor.

**Kent R. Van Horn,** Director of Research, Aluminum Company of America, New Kensington, Pa., has been elected to an honorary life membership in the Society for Nondestructive Testing. The award was made in recognition of "pioneering work in the techniques and applications of nondestructive testing in industry."

**J. A. Woodhead** has been appointed to head a newly formed promotion organization in the soap sales promotion department of Colgate-Palmolive Co., Jersey City, N. J. He was previously in the company's Soaps and Synthetic Detergents Evaluation Division.

## DEATHS...

**Benjamin J. Baskin,** Chief Engineer, Concrete Products Co. of America, Philadelphia, Pa. (February 15, 1955). Representative of company membership since 1954.

**Harold W. Browall,** Metallurgist, Inland Steel Co., Chicago, Ill. (March 9, 1955). Personal member of the Society since 1947, and representative of his company since 1946 on Committee A-1 on Steel, and its Subcommittees IV on Spring Steel and Steel Springs, V on Steel Reinforcement Bars, VI on Steel Forgings and Billets, and XV on Bar Steels.

**Meyer Goldman,** Manager, Quality Control Dept., The Visking Corp., Terre Haute, Ind. (January 11, 1955). Member of Society since 1946, and of Committee D-20 on Plastics since 1949.

**Lewis H. Kenney,** retired Chief Marine Engineer at the Philadelphia Navy Yard, died March 28, 1955, at the age of 79 years. Mr. Kenney had joined the Industrial Department of the Philadelphia Navy Yard in 1907, retiring in 1945. He was a member of ASTM for a number of years, serving on Committees A-1 on Steel and C-8 on Refractories.

**Lowell Malan,** Chief Chemist, The United Electric Coal Cos., Chicago, Ill. (January, 1955). Member of Society since 1942, serving on Committee D-5 on Coal and Coke.

# NEW MEMBERS .......

*The following 68 members were elected from February 24 to March 29, 1955, making the total membership 7879...... Welcome to ASTM*

**Note—Names are arranged alphabetically—company members first, then individuals. Your ASTM Yearbook shows the areas covered by the respective Districts.**

### CHICAGO DISTRICT

**Ingram-Richardson, Inc.**, Clark Hutchison, Director of Research, Frankfort, Ind.

**Whirlpool Corp.**, Albert Martin, Supervisor Chemical Research, 300 Broad St., St. Joseph, Mich.

**Klett, Roy A.**, Supervising Chemist, Universal Oil Products Co., Drawer "C," Riverside, Ill.

**Sauer, E. C.**, District Manager, Pittsburgh Testing Laboratory, 131 Pittsburgh Ave., Milwaukee, Wis.

**Thornley, Paul V.**, Chief Chemist, Michigan Limestone Div., United States Steel Corp., Rogers City, Mich. For mail: 264 S. Lake St., Rogers City, Mich.

### CLEVELAND DISTRICT

**Beiswenger, Hoch and Associates, Inc.**, O. L. Beiswenger, Partner, 661 W. Market St., Akron 3, Ohio.

**Joseph, Charles H., Jr.** Director of Quality Control, American Greetings Corp., 1300 W. 78th St., Cleveland 2, Ohio.

**Smith, E. W. P.**, Metallurgist, Bendix-Westinghouse Automotive Air Brakes Co., Elyria, Ohio.

### DETROIT DISTRICT

**Rinshed-Mason Co.**, Ralph L. Pitman, Director of Research, 5935 Milford Ave., Detroit 10, Mich.

**Wilde, Richard A.**, Chief Metallurgist, Eaton Manufacturing Co., 9771 French Rd., Detroit 13, Mich.

### NEW ENGLAND DISTRICT

**Archibald, Frank R.**, Analyst, Arthur O. Little, Inc., Memorial Dr., Cambridge, Mass. For mail: 18 Irving St., Melrose, Mass.

**Wilson, Paul B.**, Testing Supervisor, Belding Heminway Co., Putnam, Conn. For mail: 176 Grove St., Putnam, Conn.

### NEW YORK DISTRICT

**Concrete Industry Board**, John J. Manning, Managing Director, Room 1910, 220 E. Forty-second St., New York 17, N. Y.

**Spiral-Glas Pipe Co.**, Carl de Ganahl, Proprietor, 47 Bayard St., New Brunswick, N. J.

**Bernier, G. Raymond**, Standards Engineer, Standards Dept., Teleregister Corp., 445 Fairfield Ave., Stamford, Conn. For mail: 9 Wilbur Peck Court, Greenwich, Conn. [J]*

**Duncan, Edward T.**, Supervisor, Research Testing Lab., Harvey Hubbell, Inc., State St. and Bostwick Ave., Bridgeport, Conn. [J]

**Freudenberg, B.**, Purchasing Consultant, 240 W. 98th St., New York 25, N. Y.

**Innes, William P.**, Technical Director, MacDermid, Inc., 526 Huntingdon Ave., Waterbury 20, Conn.

**Lamb, Henry G.**, Safety Engineer, American Standards Assn., Inc., 70E. 45th St., New York 17, N. Y. For mail: 10 Wiltshire St., Bronxville 9, N. Y.

**Luttringhaus, H.**, Chemist, Progressive Color and Chemical Co., 350 Fifth Ave., New York 1, N. Y.

**Michalos, James**, Professor of Structural Engineering, and Chairman, Department of Civil Engineering, New York University, University Heights, New York 53, N. Y.

**Mitteldorf, Arthur J.**, Director, Consolidated Testing Laboratory, 79 Herricks Rd., New Hyde Park, N. Y.

**Moore, Almer F.**, Manager Service Bureau, Penn-Dixie Cement Corp., 69 E. 42nd St., New York 17, N. Y.

### NORTHERN CALIFORNIA DISTRICT

**General Paint Corp.**, H. E. Smith, Technical Director, 2280 Palou St., San Francisco 19, Calif.

### OHIO VALLEY DISTRICT

**Skinner, Malcolm K.**, Chief Metallurgist, Adams Div., LeTourneau-Westinghouse 217 S. Belmont Ave., Indianapolis 6, Ind.

**Taylor, Allan P.**, Vice-President, Ohio River Sand Co., Inc., 129 River Rd., Louisville 2, Ky.

**Upson, Helen G.**, Owner, Analytical Chemists of Cincinnati, 4 W. 7th St., Suite 47, Cincinnati 2, Ohio.

### PHILADELPHIA DISTRICT

**Magnetic Metals Co.**, H. R. Brownell, Chief Electrical Engineer, Hayes Ave. at 21st St., Camden 1, N. J.

**Sun Pipe Line Co.**, R. F. Hadley, 1608 Walnut St., Philadelphia 3, Pa.

**Gutfreund, Kurt**, Physical Chemist, Dixie Cup Co., 24th St. and Dixie Ave., Easton, Pa.

**Hetzel, Phillip R.**, Chief Inspector, Universal Ball Co., Willow Grove, Pa.

**Moran, T. D.**, Plant Engineer, South Chester Tube Co., Front and Thurlow Sts., Chester, Pa.

**Walters, L. A.**, Development Manager, The Borden Co., Chemical Div., 5000 Summerdale Ave., Philadelphia 24, Pa.

**Woodrow, Gordon R.**, Acting Metallurgist, G. O. Carlson, Inc., Thorndale, Pa. For mail: 401 W. Bernard St., West Chester, Pa.

### PITTSBURGH DISTRICT

**Frost, Charles G.**, Plant Superintendent, The Sterling Varnish Co., Haysville, Sewickley, Pa.

**Jordan, Preston E.**, Chemical Engineer, Wheeling Steel Corp., Steubenville, Ohio.

**Tschudi, Wilbur J.**, Chief Chemist, Climax Molybdenum Company of Pennsylvania, Langeloth, Pa.

**Walter, Robert J.**, Supervisor Quality Control, Wheeling Steel Corp., Steubenville, Ohio.

### ST. LOUIS DISTRICT

**Bidwell, Dana V.**, Test Engineer, The Vendo Co., 7400 E. 12th St., Kansas City 26, Mo.

**Buss, Edmund Earl**, in charge, Quality Control, The Greenleaf Manufacturing Co., 7814 Maplewood Industrial Court, St. Louis 17, Mo.

**Smith, B. E.** City Engineer, City of Wichita, 205 City Bldg., Wichita 2, Kans.

### SOUTHERN CALIFORNIA DISTRICT

**Fluor Corp. Ltd., The**, J. G. Marshall, Vice-President, General Engineering, Box 7030, Los Angeles Branch, Los Angeles 22, Calif. [S]**

**Cowing, Fordyce V.**, Superintendent, Repeal Brass Manufacturing Co., 2115 E. 27th St., Los Angeles 58, Calif. For mail: 1457 Oaklawn Rd., Arcadia, Calif.

### SOUTHWEST DISTRICT

**Boydstun, Ira S.**, Sales Manager, Petrolite Corp., Box 2546, Houston 1, Tex.

**Reinberg, Henry C.**, Chemical Engineer, Louisiana State Department of Revenue Capitol Annex, Baton Rouge, La. For mail: 1958 Tulip St., Baton Rouge 6, La.

*(Continued on page 88)*

* [J] denotes Junior members.
** [S] denotes Sustaining member.

## FOR LADIES ONLY!

*The Philadelphia District will again be hosts for the Atlantic City Meeting. Your wife will enjoy this program.*

**Monday, June 27:**

9:30 to 10:30 a.m.—Coffee hour

3:00 p.m.—Afternoon tea and informal get-acquainted party. Mrs. Agnes Smith will discuss floral arrangements and points in judging floral displays.

**Tuesday, June 28:**

9:30 to 10:30 a.m.—Coffee hour

12:00 m.—ASTM luncheon with President's Address, awards and introduction of new officers.

8:00 p.m.—Fashion show—door prizes.

**Wednesday, June 29:**

9:30 to 10:30 a.m.—Coffee hour

11:00 a.m.—Sight seeing trip of Atlantic City by boat.

6:30 p.m.—Cocktails (dutch) preceding ASTM annual dinner.

7:30 p.m.—ASTM annual dinner and entertainment.

**Thursday, June 30:**

9:30 to 10:30 a.m.—Coffee hour

12:00 m.—Smorgasbord luncheon. Mrs. Rae V. Biester, Superintendent, U.S. Mint, will be the guest speaker—"Making Money—A Fascinating Business."

**Friday, July 1:**

9:30 to 10:30 a.m.—Coffee hour

**ASTM 58th Annual Meeting**
**June 26–July 1, 1955**
**Atlantic City, N. J.**

(*Continued from page 87*)

WASHINGTON (D. C.) DISTRICT

**Immer, Charles A.,** President, Immer and Co., 3715 Livingston St., N. W., Washington 15, D. C.

**Mattern, Edwin K.,** Professional Engineer, Hayes, Seay, Mattern & Mattern, 1615 Franklin Rd., S. W., Roanoke, Va.

**North Carolina State College, Civil Engineering Dept.,** Ralph E. Fadum, Head of Department, Raleigh, N. C.

**Sadler, Joseph B.,** Engineering Section, Southern Material Co., Inc., Box 420, Norfolk, Va.

**Wiedmer, Norman J.,** Vice-President, Hopkinsville Stone Co., Inc., Box 41, Hopkinsville, Ky.

WESTERN NEW YORK-ONTARIO DISTRICT

**Juel, Leslie H.,** Manager, Research and Development Dept., Great Lakes Carbon Corp., Box 637, Niagara Falls, N. Y.

UNITED STATES AND POSSESSIONS

**Ferer and Sons Co., Aaron,** Harvey D. Ferer, Vice-President, 101 S. 8th St., Omaha 8, Nebr.

**Darlow, Arthur E.,** Director of Engineering, City of Miami, Box 708, Coconut Grove Station, Miami 33, Fla.

**Haynes, W. G.,** Research Chemist, Union Pacific Railroad Co., 9th and Cass Sts., Omaha 2, Nebr.

**Kyle, J. V.,** President, Atlanta Concrete Pipe Corp., Box 26, Station A, Atlanta, Ga.

**Miami, University of, Library, Serials Dept.,** Coral Gables 46, Fla.

OTHER THAN U. S. POSSESSIONS

**Associated Ethyl Co., Ltd., The,** P. V. Lamarque, Manager, Engine Lab., Watling St., Bletchley, Bucks, England.

**Auckland Metropolitan Drainage Board,** C. C. Collom, Chief Engineer, Box 208, Auckland, C.1, New Zealand.

**Empire Brass Foundry Ltd.,** Alexander Bruce, President, 137 Nazareth St., Montreal 3, P. Q., Canada.

**Capacete, Jose L.,** President, The Foundation Engineering Company of Puerto Rico, Box 9684 Santurce, Puerto Rico.

**Cox, Lionel A.,** Director of Research, Johnson & Johnson, Ltd., 2155 Pius IX Blvd., Montreal, P. Q., Canada.

**Delvaux, Ed.,** Chief of Laboratory, 133, rue Lambot, Aiseau, Belgium.

**Gillam, Gerald Hugh,** Chief Engineer, Taylor, Tunnicliff and Co., Ltd., Box 17, Eastwood, Hanley, Stoke-on-Trent, England.

**Kokubu, Masatane,** Professor, and Doctor of Engineering, University of Tokyo, Dobolukyoshitsu, Kogaku-bu, Tokyo Daigaku, Bunkyo-ky, Tokyo, Japan.

**Recine, Arnoldo,** General Manager, Scuola della Lubrificazione, via Bocchella 2, Genoa, Italy.

**Schneider, Alfred,** Chief Chemist, St. Lawrence Cement Co., Box 1156, Quebec, P. Q., Canada.

**Sykes, John,** Technical Information Officer, The Furniture Development Council, 11 Adelphia Terrace, London WC 2, England.

**Taniguchi, Husao,** Head, Documentation Section, Matsushita Electric Ind. Co., Ltd., Central Labs., Kadoma, Kadomacho, Kitakawachi, Osafa-fu, Japan.

**Thomas, Kurt,** Director, Verein Deutscher Eisenhuttenleute, Breite Strasse 27, Dusseldorf, Germany

## Guide for Safety in the Chemical Laboratory

**D. Van Nostrand Co., Inc., New York, N. Y., 234 pp., $4.25.**

Safety is a byword of modern industry. The financial problems incident to accident liability and time lost by personnel are enough to give any organization pause. Any safety program is a case of "a stitch in time saves nine." To aid organizations in establishing safety programs for handling hazardous chemicals, materials, and laboratory apparatus, the General Safety Committee of the Manufacturing Chemists Assn. has published an informative text, complete with many illustrations and tables. This book discusses laboratory design and equipment, handling glassware, storage containers, chemical hazards, toxicity, radiation safety and control, pressure vessel hazards, protective equipment, and first aid.

# NEWS NOTES ON

# Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses

## NEW PRODUCTS

**Polyethylene Pipet Jars**—Lightweight, unbreakable pipet jars, made of high molecular weight virgin polyethylene are chemically resistant to most acids, alkalis, and caustic cleaning solutions at temperatures up to 150 F.
*American Agile Corp., P.O. Box 168, Bedford, Ohio.*

**Quantograph**—This new instrument combines the features of a spectrograph, a monochromator, and the ARL "Quantometer," and performs the complete functions of each.
*Applied Research Laboratories, Glendale, Calif.*

**Improved Spectrochemical Source Unit**—Changes in construction, says the manufacturer, have resulted in a more flexible and versatile unit suitable for analyzing solids, liquids, and powders, with elements in wide ranges of concentration.
*Applied Research Laboratories, Glendale, Calif.*

**X-Ray Scanning Spectrometer**—A new non-destructive X-ray analytical tool suitable for qualitative or semiquantitative analysis.
*Applied Research Laboratories, Glendale, Calif.*

**D-C Expanded Scale Voltmeter**—A new line of d-c Expanded Scale Voltmeters for panel mounting and accurate to ½ per cent of input voltage has been added to its line of a-c Expanded Scale Voltmeters.
*Arga Div., Beckman Instruments, Inc., 200 Pasadena Ave., South Pasadena, Calif.*

**Flowmeter Calibration System**—Based on time and weight measurements with a standard Baldwin SR-4 Load Cell.
*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*

**Vapor-Temp Controlled Humidity Cabinet**—A versatile and accurate low cost mechanical convection temperature-controlled relative humidity cabinet, known as VAPOR-TEMP.
*Blue M Electric Co., 138th & Chatham St., Blue Island, Ill.*

**Rheometers**—For the measurement of viscosity at high rates of flow in control, formulation, research, and production processes.
*Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.*

**Gelometer**—A new instrument for the automatic determination of gelation time or stability of polyesters and phenolics in research, control, or production.
*Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.*

**Miniaturized Rotary Selector Switch**—Slightly larger than a penny in diameter yet providing for a wide range of multi-switching operations.
*Clarostat Mfg. Co., Inc., Dover, N. H.*

**Surface Abrader**—The unit is capable of reproducing either unidirectional or multidirectional abrasion of uniform intensity over the abraded area.
*Custom Scientific Instruments, Inc., Arlington, N. J.*

(*Continued on page 93*)

(*Continued from page 90*)

**Electronic Counter**—Featuring printed circuits and a miniature high-speed mechanical register combined with one electronic decade, inexpensive counter is capable of a sustained counting rate of 200 counts per second.
*Daytronic Corp., 216 S. Main St., Dayton 2, Ohio.*

**Dynamic Balancing Machine**—Capable of measuring and correcting dynamic unbalance of high-speed rotors to better than one-one hundred thousandth of an inch-ounce.
*Decker Aviation Corp., 1261 Frankford Ave., Philadelphia 25, Pa.*

**Contour Projector**—A portable bench-type Contour Projector which is equally adaptable for either horizontal or vertical projection gaging.
*Special Products Sales Div., Eastman Kodak Co., Rochester 4, N. Y., or Optical Gaging Products, Inc., 26 Forbes St., Rochester 11, N. Y.*

**Variable Speed Shaker**—Mechanical speed control guarantees the user constant speed at whatever setting he chooses between 60 and 260 oscillations per minute.
*Eberbach Corp., Ann Arbor, Mich.*

**Measuring Magnifier**—A new "vest-pocket" size version of pocket comparator employs a glass reticle, instead of the film reticle found on other low priced miniature comparators.
*Edmund Scientific Corp., Barrington 3, N. J.*

**Oscilloscope**—A new dual-channel oscilloscope, priced within reach of laboratories, research and engineering departments—yet with band-width, sensitivity, gain, and frequency response to spare in 9 out of 10 testing and measuring applications.
*Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.*

**All-Electronic Spectrograph**—An all-electronic direct-reading spectrograph that analyzes up to 65 different elements in two minutes.
*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

**Isotemp Oven**—Senior Forced-Draft Isotemp Oven combines high drying speed (two to three times that of ordinary gravity-convection units) with large capacity (nearly 1000 sq in. of shelf space).
*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

**Scratch-Hardness Tester**—This instrument fills the need for a small, easy-to-handle instrument for testing scratch-hardness and adhesion of industrial product finishes.
*Gardner Laboratory, Inc., Bethesda 14, Md.*

**Pycnometer**—A plastic pycnometer of new design offers a wide range of utility for industrial testing and laboratory work.
*Gardner Laboratory, Inc., Bethesda 14, Md.*

**Bottle Shaker**—Carefully designed and compactly constructed to provide speed, efficiency, and versatility in general laboratory mixing.
*Gardner Laboratory, Inc., Bethesda 14, Md.*

**"See-Thru" Drawers**—A sturdy steel cabinet with eight crystal-clear, "See-Thru" drawers will answer many small-parts storage needs.
*General Industrial Co., 5738 N. Elston Ave., Chicago 30, Ill.*

**Single Deck Switch**—A new single deck switch incorporating a positive detent action has been added to established line of miniature tap switches.
*Grayhill, 561 Hillgrove Ave., LaGrange, Ill.*

**Special Applications Switches**—A line of electrical switches of instrument-quality type featuring highest quality materials, workmanship, and design.
*Industrial Instruments, Inc., Cedar Grove, N. J.*

**E-Scope**—A sonic analyzer for non-destructive testing of solid and visco-elastic materials, the E-Scope is used to obtain elastic moduli and damping factors, providing sensitive measurement of the effects of natural or induced deterioration, flaws or inclusions, or product uniformity.
*Kinetic Instrument Co., 3250 Skokie Valley Rd., Highland Park, Ill.*

(*Continued on page 96*)

## CALENDAR OF OTHER SOCIETIES' MEETINGS

May 6—**American Assn. of Spectrographers,** Sixth Annual Conference, Chicago, Ill.

May 7–15—**Society of the Plastics Industry, Inc.,** SPI Annual Meeting and Conference, Cruise on the *Queen of Bermuda.*

May 9–12—**American Petroleum Institute,** Division of Refining Mid-Year Meeting, Jefferson Hotel, St. Louis, Mo.

May 10–11—**American Institute of Electrical Engineers,** Electric Heating Conference, La Salle Hotel, Chicago, Ill.

May 10–12—**Metal Powder Assn.,** Show, Philadelphia, Pa.

May 11–13—**American Inst. of Chemists,** Annual Meeting, La Salle Hotel, Chicago, Ill.

May 12–13—**Society for Applied Spectroscopy,** Annual Meeting, Hotel New Yorker, New York, N. Y.

May 12–13—**Illuminating Engineering Society,** Canadian Region, Mt. Royal Hotel, Montreal, Canada.

May 16–19—**American Mining Congress,** Coal Show, Public Auditorium, Cleveland, Ohio.

May 16–20—**Sixth National Materials Handling Exposition,** International Amphitheater, Chicago, Ill.

May 16–20—**National Fire Protection Assn.,** Annual Meeting, Netherland-Plaza Hotel, Cincinnati, Ohio.

May 17–19—**Assn. of American Railroads,** Annual Session, St. Francis and Sir Francis Drake Hotels, San Francisco, Calif.

May 18–20—**American Institute of Electrical Engineers,** Telemetering Conference, Morrison Hotel, Chicago, Ill.

May 18–21—**Pulp and Paper Industry,** Third Western International Meeting, Empress Hotel, Victoria, B. C.

May 19–20—**Illuminating Engineering Society,** East Central Region, Abraham Lincoln Hotel, Reading, Pa.

May 22–25—**American Leather Chemists Assn.,** New Ocean House, Swampscott, Mass.

May 22–26—**Air Pollution Control Assn.,** Sheraton-Cadillac Hotel, Detroit, Mich.

May 23–25—**American Society for Quality Control,** Ninth Annual Convention, Statler Hotel, New York, N. Y.

May 23–27—**American Foundrymen's Society,** 59th Annual Convention, non-exhibit, Houston, Tex.

May 31–June 3—**Third Basic Materials Exposition,** Convention Hall, Philadelphia, Pa.

June 2–4—**National Society of Professional Engineers,** Annual Meeting, Bellevue-Stratford Hotel, Philadelphia, Pa.

June 8–10—**American Meteorological Society,** 137th Meeting, Kansas City, Mo.

June 10–11—**Illuminating Engineering Society,** Northeastern Region, Ft. Wm. Henry Hotel, Lake George, N. Y.

June 12–17—**Society of Automotive Engineers,** National Meeting, Golden Anniversary Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 13–16—**Edison Electric Institute,** Annual Convention, Los Angeles, Calif.

June 14–16—**AIEE, APS, AIME, CIT,** Magnetics Conference, William Penn Hotel, Pittsburgh, Pa.

June 16–17—**Armed Forces Chemical Assn.,** 10th Annual Meeting, Cleveland, Ohio.

June 16–18—**Malleable Founders' Society,** Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va.

June 19–23—**American Society of Mechanical Engineers,** Diamond Jubilee Annual Meeting, Statler Hotel, Boston, Mass.

June 20–22—**American Society of Heating and Air-Conditioning,** Engineers Semi-Annual Meeting, San Francisco, Calif.

June 20–23—**Forest Products Research Society,** Annual Meeting, Seattle, Wash.

June 20–24—**American Society for Engineering Education,** Annual Meeting, Pennsylvania State University, State College, Pa.

June 20–25—**American Electroplaters' Society,** Annual Convention and Industrial Finishing Exposition, Cleveland, Ohio.

June 21–23—**Assn. of American Railroads,** Sheraton-Mt. Royal Hotel, Montreal, Canada.

June 21–24—**Institute of Aeronautical Sciences,** Jt. Meeting with Royal Aeronautical Society of Great Britain, 5th International Aeronautical Conference, IAS Building, 7660 Beverly Blvd., Los Angeles, Calif.

June 26–July 1—**American Society for Testing Materials,** Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 27–29—**American Society of Heating and Air Conditioning Engineers,** Semiannual Meeting, San Francisco, Calif.

June 27–July 1—**American Institute of Electrical Engineers,** Summer General Meeting, New Ocean House, Swampscott, Mass.

(Continued from page 93)

**Technical Balance**—The Reyers-Rapid is the first technical balance (1-kg capacity) equipped with a chain loading device that dispenses with fractional weights.
*Arthur S. LaPine & Co., 6001 S. Knox Ave., Chicago 29, Ill.*

**Oxyater**—An instrument for determining oxygen in metals by the bromination method.
*Ledoux & Co., 359 Alfred Ave., Teaneck, N. J.*

**Portable Atomic X-ray**—Iso-X, a completely portable radioactive isotope X-ray machine, is admirably suited for the inspection of seams, welds, forgings, light castings, and relatively inaccessible areas in completed structures, such as airframes and wings.
*Nuclear Electronics Div., Litton Industries, Beverly Hills, Calif.*

**Gas Analyzer**—X-ray absorption gas analyzer designed for rapid quantitative analysis work in chemical and related fields.
*Research & Control Instruments Div., North American Philips Co., 750 S. Fulton Ave., Mount Vernon, N. Y.*

**Electronic Load Cell**—An electronic load cell that permits more accurate low-capacity testing with standard testing machines.
*Tinius Olsen Testing Machine Co., 4072 Easton Rd., Willow Grove, Pa.*

**Triaxial Shear Testing**—All controls necessary for both routine and special triaxial shear testing of soil are incorporated in the compact Olsen K-W Triaxial Testing Machine.
*Tinius Olsen Testing Machine Co., Easton Rd., Willow Grove, Pa.*

**Automatic Reid Vapor Pressure Recorder**—An accurate, dependable means of monitoring the blending of motor gasolines to obtain the most economical ratio of butane to base stock.
*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

**Micro-Bellows Pump**—New unit offers a more accurate metering by the use of the synchronous motor and precision setting screw.
*Research Appliance Co., Box 463, West View Rd., Pittsburgh 9, Pa.*

**Laboratory Heater**—A new economical-type heater for general laboratory use in distillations, evaporations, digestions, or extractions.
*Dept. ASTM, E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill.*

**Range Indicator**—A new, portable, high-speed, self-contained indicator that gives a quick and accurate indication of pressure, temperature, force, and displacement by means of pickups using the output of 60-cycle linear variable differential transformers.
*Schaevitz Engineering, Camden 1, N. J.*

**Sepor Microsplitter**—A specially designed Jones type riffle used for mixing fine-grained materials and obtaining homogeneous splits and microsamples.
*Sepor Microsplitter Supply, 1545 S. Oak Park Ave., Berwyn, Ill.*

**Blush Cabinet**—Designed to enable users and manufacturers of lacquers to determine the blush resistance of their lacquers with the maximum speed and accuracy.
*Sharples Chemicals, Inc., R & D Div., P.O. Box 4388, Philadelphia 18, Pa.*

**Universal Recording Balance**—Direct, continuous measuring and recording of force *versus* time.
*Sharples Corporation Research Labs., Bridgeport, Pa.*

**Tap Analyzer**—The most elaborate and most accurate measuring microscope to provide means for holding a tap in a firm position and in a definite relationship to the several calibrated motions of the instrument.
*Stoker & Yale, Inc., 332 Green St., Marblehead, Mass.*

**Automatic Voltage Regulator**—An automatic voltage regulator designed for unattended installations operates without tubes or moving parts.
*The Superior Electric Co., Bristol, Conn.*

(Continued on page 98)

(Continued from page 96)

**Pressure Indicators**—New line of pressure indicating instruments employs an advanced electrical circuit which eliminates troublesome components such as 400-cycle choppers and vacuum tubes. There are no moving parts other than those of the meter.
*Taber Instrument Corp., 111 Goundry St., N. Tonawanda, N. Y.*

**Temperature Controller**—Combination of precision, dependability, and range of this controller makes the applications of the Electron-o-Therm Senior extremely varied in both plant and laboratory.
*Technical Equipment Co., 743 Dwight Way, Berkeley 10, Calif.*

**Dry Ice Test Chamber**—A new high- and low-temperature environmental testing chamber, incorporating a removable dry ice compartment as a source of cold air.
*Tenney Engineering, Inc., 1090 Springfield Rd., Union, N. J.*

**Temperature-Sensing Probes**—New probes now available for use with the YSIC Thermistor Tele-Thermometer feature fast response, small size, and a wide variety of applications.
*Yellow Springs Instrument Co., Inc., P.O. Box 106, Yellow Springs, Ohio.*

## CATALOGS AND LITERATURE

**Spectromet**—*Bulletin No. 42* discusses a small direct reading instrument for quality control directly on the foundry floor.
*Baird Associates, Inc., 33 University Rd., Cambridge 38, Mass.*

**Sterilshield Cabinets**—Two new bulletins, *Form No. SC-120* and *Form No. SC-140*, describe Model 12 and Model 14 Sterilshield Cabinets (dust-free work benches).
*The Baker Co., Inc., Maplewood, Me.*

**Cooling Tower Pumps**—*Six Step Manual* for sizing cooling tower pumps and piping.
*Bell & Gossett Co., Morton Grove, Ill.*

**Laboratory Thermometers**—*Catalog 55-A* contains specifications and prices of over 850 thermometers, and introduces the revolutionary Un-Etched thermometers.
*Brooklyn Thermometer Co., 217-09 Merrick Blvd., Springfield Gardens, N. Y.*

**Computer Components**—Two brochures, *Research and Development* and *Universal Logical Building Blocks*.
*Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.*

**Mass Spectrometer**—*Bulletin 1800C* describes the adaptability of this instrument to exploratory analyses and research investigations.
*Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.*

**Axicon**—A new data booklet describing the Kodak Axicon and its application to alignment problems incorporates the first engineering discussion of a basically new type of optical element, which is neither a lens nor a prism.
*Special Products Sales Div., Eastman Kodak Co., 343 State St., Rochester 4, N. Y.*

**Science in the Dog House**—Vol. 24, No. 3 of *The Laboratory* features the first published account anywhere of the new theory of immunity, of vital importance to human beings, albeit a result of research originally intended to benefit Mr. Dog alone.
*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

**Laboratory Recorder**—Twelve-page *Bulletin FS-251* gives facts and figures on new laboratory recorder that converts manual laboratory instruments into automatic, recording instruments.
*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

**Newsletter No. 9**—Several new instruments are described herein which include a new Pressurized Viscosity Cup, Gardner Vertical Viscometer Kit, Chip Resistance Tester, New Ford Cup Stand, and the Blue M Constant Flow Portable Coil Cooling Unit.
*Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md.*

**Hardness Tester**—*Bulletin No. A-16* describes and illustrates the Wolpert-Gries "Micro-Reflex" hardness tester with optical system by Carl Zeiss, designed for loads from 10 to 300 g.
*Gries Industries, Inc., Testing Machines Div., New Rochelle 4, N. Y.*

(Continued on page 100)

(Continued from page 98)

**Side Indicator Panel Meter**—An Engineering Data Sheet just published by International Instruments Inc., New Haven, Conn., describes and gives complete performance information on a new series of large Side Indicator Panel Meters.
*International Instruments Inc., P.O. Box 2954, New Haven 15, Conn.*

**Electrical Standard Resistors**—The specifications of a complete line of d-c electrical standards as well as secondary standard a-c resistors are given in a four-page *Data Sheet EB2(1)*.
*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.*

**Porous Stainless Steel Filters**—Range of stock filters available with porous stainless steel elements, prices and application data are contained in a *Bulletin 213*.
*Micro Metallic Corp., Glen Cove, N. Y.*

**Test Chambers**—*Data Sheet 11.0-9* describes the application of Brown instruments to the control of environmental test chambers made by International Radiant Corp.
*Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.*

**SR-4 Testing Machine**—*Data Sheet 10.17-5* describes machine capable of testing specimens or structural parts and components in tension, compression, flexure, torsion, alternating load, creep, stress relaxation and shock, up to a rated capacity of 50,000 lb.
*Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Phila. 44, Pa.*

**X-ray Diffractometer and Spectrograph**—*Data Sheet 10.16-lb*, recently revised, describes the Norelco X-ray Diffractometer and Spectrograph, a valuable tool in X-ray powder diffractometry, quantitative and qualitative analysis, and other fields.
*Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.*

**Universal Calibrating Machine**—*Bulletin No. 115* describes the Morehouse Universal Calibrating Machine designed for calibrating load cells and other portable force measuring instruments.
*Morehouse Machine Co., 233 W. Market St., York, Pa.*

**Bronze Sintered Filters**—How "a handful of bronze balls started a new industry" is explained in a 16-page catalog of sintered bronze filters.
*Permanent Filter Corp., 1800 W. Washington Blvd., Los Angeles 7, Calif.*

**Analog Instruments**—Showing on one sheet a representative selection of analog instruments, this bulletin offers a quick survey of products and computing techniques.
*George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.*

**Copper Strip Corrosion Test Bomb**—Precision Scientific Co. has published *Data Sheet No. 11515* on the new ASTM-approved Copper Strip Corrosion Test Bomb to be used for ASTM D 130 "Test for Copper Corrosion by Petroleum Products."
*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

**Testing Machines Guide**—This eight-page guide indicates the broad range of machines, instruments, and accessories available from one source.
*Riehle Testing Machines Div., American Machine and Metals, Inc., East Moline, Ill.*

**Lab-ORATORY**—New 16-page issue of *Lab-ORATORY* describing Blue M "Power-O-Matic" ovens; Fraction Collector for chromatographic work; and Ainsworth "Right-A-Weigh" Balance featuring mechanical weight handling.
*Schaar and Co., 754 W. Lexington St., Chicago 7, Ill.*

**Screening Data**—Your copy of a brand new Data File has been specially prepared for the processing industries and is entitled, *"The Principles and Applications of a Revolutionary Screening Device."*
*Southwestern Engineering Co., 4800 Santa Fe Ave., Los Angeles 58, Calif.*

## INSTRUMENT COMPANY NEWS

**H. Reeve Angel & Co., New York, N. Y.**—Thomas L. Harrocks, Jr. has been appointed sales manager of H. Reeve

(Continued on page 101)

(*Continued from page 100*)

Angel & Co., Inc., distributors of Whatman and Reeve Angel Filter Papers.

**Fisher Scientific Co., Pittsburgh, Pa.**—Claude A. Pamplin transfers to Eimer & Amend Div. of Fisher Scientific in New York as asst. vice-president. Robert A. Piper, until recently with the St. Louis branch, succeeds him as sales manager of the Silver Spring, Md., branch.

**Leeds & Northrup Co., Philadelphia, Pa.**—A. E. Tarr, formerly manager of the company's sales engineering division, is appointed assistant to the president. He is succeeded by Harold L. Scutt, formerly sales manager of the New York district, who moves his activities to Philadelphia. Nathan Cohn, formerly manager of the west central sales region, moves to Philadelphia to be manager of the market development division. He replaces L. E. Emerich who recently was named director of marketing. H. Raymond Abey, who has been manager of the eastern sales region, is appointed manager of the marketing services division, succeeding the late A. Merrill Redding. J. William Robinson, formerly manager of the western sales region, becomes western sales manager.

**Scott Testers, Inc., Providence, R. I.**—Scott Testers (Southern), Inc., the southern repair and service center for equipment manufactured by Scott Testers, has erected a new plant in Spartanburg, S. C. Parts will be stocked, and a staff of factory-trained service personnel will be available for repair work. John E. Hargreaves will serve as general manager of the Spartanburg plant.

**NRD Instrument Co., St. Louis, Mo.**—NRD Instrument Co. is the instrument producing and distributing part of the company formerly known as Nuclear Research and Development Corp.

## NEWS OF LABORATORIES

**American Council of Independent Laboratories, Inc.**—The American Council of Independent Laboratories has elected Lewis F. Herron of James H. Herron Co., president of the organization. Other officers are vice-president, Alvin C. Purdy of Bull & Roberts; Secretary, Roger W. Truesdail, Truesdail Labs.; and treasurer, F. H. Wright, Lucius Pitkin, Inc. Herbert D. Imrie, president of Abbot A. Hanks, Inc., has been elected to the Executive Committee of the American Council of Independent Labs., Inc. and will serve a three-year term.

**Machlett Laboratories, Inc., Springdale, Conn.** D. T. O'Connor has been appointed director, Industrial X-Ray Engineering. He was previously with Naval Ordnance Lab., U. S. Department of Defense, as Chief of Radiology Section.

**Pittsburgh Testing Laboratory, Pittsburgh, Pa.**—Pittsburgh Testing Laboratory has announced the election of C. M. Houck, chairman of the board; R. E. Emmett, president; and James K. S. Ruby, vice-president and secretary.

**Foster D. Snell, Inc., New York, N. Y.**—Shephert Stigman has been promoted to assistant director of Personnel and Public Relations. Formerly assistant to the director of Personnel and Public Relations, he joined Foster D. Snell, Inc. as a chemist in 1951.

## INDEX TO ADVERTISERS